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The Purchase Tax

In our issue of June 20, we dealt with the repercussions on the foundry industry of the Limitation of Supplies (Miscellaneous) Order, 1940, and indicated the nature of the goods so restricted. The schedule on which this Order was based is virtually the same as that underlying the imposition of the Purchase Tax. On that occasion we drew attention to the omission of garden rollers from the schedule, and their inclusion in category 9 will occasion no call for surprise. Obviously, the imposition of the tax involves the further filling up of forms, and for this purpose any foundry organisation making any of the goods chargeable must register on Form P.T.1, obtainable from the Custom House, London, E.C.3. The final date for registration is September 20, and after that time firms which should have registered, but have failed to do so, are liable to a penalty of £100 and £10 for each day during which the failure to register continues, in addition to the tax on the goods concerned. Every foundry owner who makes and sells chargeable goods is required to register unless his gross takings from the sale of chargeable goods do not on the average exceed £2,000 per annum, but as far as we can see, this will preclude them from taking orders on chargeable goods in the future. It is important to note that firms engaged in making goods which are not chargeable with tax are not required to register, but provision exists for registering such firms where they can show that they use chargeable goods in substantial quantities as materials in manufacture. Whilst the majority of foundries catering for the retail trade sell to merchants, some sell direct to the large multiple-store companies, and in this case the Commissioners are taking steps to register such firms, just as if they were wholesalers.

After registration, firms will receive a numbered certificate, which will enable them to obtain free of tax from other registered firms any chargeable goods required as material for use in manufacture or as stock for wholesale trading. The quoting of the registered number is an essential, and misuse in any way makes a person liable to heavy penalties. A registered firm selling goods to an unregistered customer (or to a registered firm not buying the goods as material or stock) will be accountable for tax on the transaction. The amount of the tax must be shown separately on the invoice for the goods. Apparently delivery expenses are deductible and, where these are not readily obtained, they may be calculated by an approved appropriate method.

The Commissioners urge that all firms which manufacture chargeable goods should register immediately and not wait for the official closing date. By so doing, registered firms will be placed in the position of being able to obtain goods straight away. As we stated earlier, the list of chargeable goods is much the same as that scheduled in connection with the Limitation of Supplies Order, but as a result of Parliamentary action, a few modifications of interest to the foundry industry have been made. For instance, it is interesting to note that enamelled hollow-ware and other iron and steel hollow-ware of a kind used for domestic purposes are to be charged at one-sixth of their wholesale value and not at one-third, that is, the standard rate of taxation.

There is still a query of some little importance to the foundry industry in connection with shot-blast helmets. Protective helmets designed for use by miners or quarrymen are exempt, and we think that common sense will allow of extension to cover the application indicated. In the case of protective boots, there is tax exemption in the cases where they are designed for use by miners, quarrymen and moulders. Generally speaking, though the Purchase Tax is meant eventually to fall upon the man in the street, where firms buy such commodities they will have to bear the tax, a typical case being that of electric filament lamps (under 250 watts).

A Year of War

The incidence of a year of wartime activities on the foundry industry has been profound, but evolutionary. The course taken is much as was to be expected and has resulted in record outputs by the steel-foundry section, the heavy iron-castings foundries and the non-ferrous shops. Only in the light castings trade has slackness been experienced, but here again the effect has been anything but uniform. Though this is by no means a "cast-iron" war, important contracts are entered into for cast-iron munitions of war of a light character.

Most of the technical societies have arranged full programmes for the Autumn and Spring, and a lead in this direction is being given by the Institute of British Foundrymen, for again the majority of its Branches will be as active as usual. The early discomforts occasioned by the blacking out of foundries are gradually being overcome by the installation of light traps and improved ventilating systems. A wartime organisation, the Ironfounders' National Confederation, has made such progress that it is now the largest in the industry, and at the moment it can be regarded as the co-operative selling organisation for iron castings.

Unemployment Insurance

CHANGES UNDER NEW ACT

The Unemployment Insurance Act, 1940, not only makes alterations in the rates of contributions and benefits, but also makes the scheme applicable to more employees (as from September 2, 1940) because non-manual workers with earnings up to £420 a year (the former limit was £250) have been brought into this insurance field. By this provision, these employees will, of course, be eligible for all benefits, in the same way as other workers formerly covered by the scheme, that is, when qualified and when unemployed. To secure insurance benefit, 30 contributions must have been registered in the two years prior to the date of any claim to benefit; furthermore, unemployment allowances will also be available when and if insurance benefit is exhausted in any benefit year (provided that the means test under this scheme can be fulfilled).

The "continuity of unemployment" rule is also altered. Whereas three unemployed days were required to be registered in a period of six consecutive days for benefit to be payable for each of those days, now two days of unemployment (not necessarily consecutive) registered in a period of six consecutive days, reckoned backwards or forwards, will be sufficient to meet the rule. The position now is that if two days unemployed and four days at work constitute a week, benefit will be payable for those two days, whereas formerly these unemployment signatures were not effective for benefit.

Benefit and contribution rates under both the agricultural and general schemes have been increased for certain age groups, but the rates for boys and girls remain unchanged.

Benefit rates under the general scheme are increased as follow:— For males of 21 years and over, 20s. (increased from 17s.); between 18 and 21 years, 16s. (from 14s.); between 17 and 18 years, 9s., and under 17 years, 6s. For females of the same age groups, the rates are 18s. (increased from 15s.), 14s. (from 12s.), 7s. 6d. and 5s. respectively.

Under the general scheme, the stamps (operative from August 5, 1940) now cost as follows:— For males of 21 years and over, 1s. 8d. (increased from 1s. 6d.); between 18 and 21 years, 1s. 6d. (from 1s. 4d.); between 16 and 18 years, 10d.; and under 16 years, 4d. For females of the same age groups, the rates are 1s. 6d. (increased from 1s. 4d.), 1s. 4d. (from 1s. 2d.), 9d. and 4d. respectively. Half of these amounts can be recovered from the employee. These rates, of course, will also be payable by the new entrants (higher salaried persons) mentioned earlier.

Catalogues Received

Paints for Metal Surfaces. We recently outlined the physical properties of "Kemick," a heat-resisting paint capable of withstanding temperatures up to 500 deg. C., and now we have received from I.C.I. (Paints), Limited, of Wexham Road, Slough, Bucks, a price list covering this and a number of other specialised products of an equally interesting character. This list is available to our readers on application.

Ultra-Violet Ray Treatment. Watson & Sons (Electro Medical), Limited, of 76, Castle Street, Reading, have prepared an illustrated folder carrying the caption, "The Black-out and the Health of the Worker." The folder tells of the ameliorative effect on the health of people by the installation of artificial sun-bathing apparatus in industrial establishments. The design is such that quite a number can receive simultaneous treatment.

Tests for Laboratory Porcelain

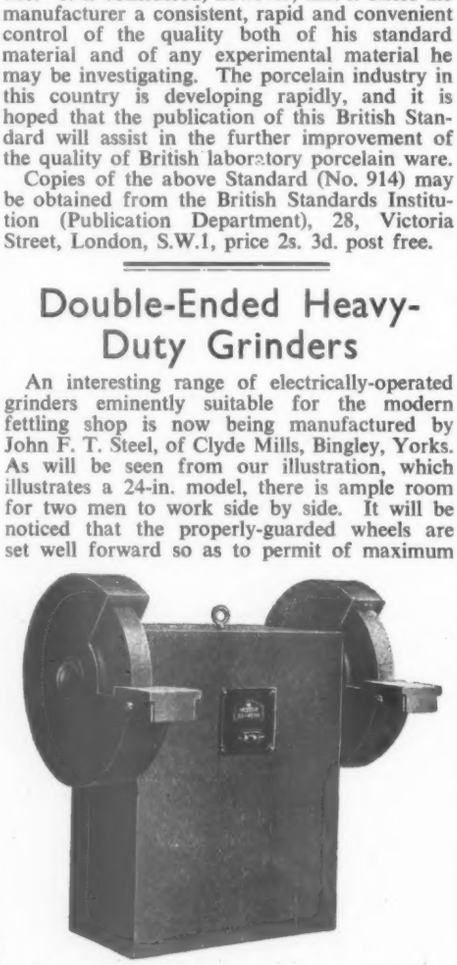
The British Standards Institution has just issued a British Standard, No. 914, for Tests for Laboratory Porcelain. The tests included are: Appearance, shape, weight, etc., porosity of body and imperfections in glaze (dye test), resistance to heat and sudden change of temperature, constancy of weight and resistance of glaze to high temperature and resistance of glaze to acid and alkali. The tests thus provided are intended to be helpful both to the manufacturer and the user; to the former in helping him to improve his product, and to the latter in assisting him to avoid the disappointment of porcelain ware being found defective in actual use, although its defects were not previously evident.

Several tests are based on those adopted by the sub-committee on porcelain of the Glass Research Committee of the Institute of Chemistry and published in 1920. One test, however, that of the resistance to heating and cooling, is entirely new, it being an accelerated test, having no counterpart in laboratory practice. It is considered, however, that it offers the manufacturer a consistent, rapid and convenient control of the quality both of his standard material and of any experimental material he may be investigating. The porcelain industry in this country is developing rapidly, and it is hoped that the publication of this British Standard will assist in the further improvement of the quality of British laboratory porcelain ware.

Copies of the above Standard (No. 914) may be obtained from the British Standards Institution (Publication Department), 28, Victoria Street, London, S.W.1, price 2s. 3d. post free.

Double-Ended Heavy-Duty Grinders

An interesting range of electrically-operated grinders eminently suitable for the modern fettling shop is now being manufactured by John F. T. Steel, of Clyde Mills, Bingley, Yorks. As will be seen from our illustration, which illustrates a 24-in. model, there is ample room for two men to work side by side. It will be noticed that the properly-guarded wheels are set well forward so as to permit of maximum



24-IN. MODEL OF "IMPETUS" GRINDER BY JOHN F. T. STEEL, OF BINGLEY.

usage, whilst the design provides ample clearance around the wheel. The model referred to is provided with splash arrestors and is actuated by a built-in continuously rated 10 h.p. motor, conforming to B.S.I. specifications. The distance between the wheels is 41 in., the overall height being 50½ in. It is 33¼ in. deep, whilst the tool rests are set at 36 in. The tool, which is of all-steel construction, is equipped with push-button starter with overload and no-volt release. The main spindle is mounted on extra-heavy taper roller bearings and the drive from the motor is by multiple V-ropes.

In addition to the machine taking 24-in. wheels described above, the range is completed by smaller ones designed to work with 20, 14, 12, 9 and 6 in. wheels. The three smallest sizes are available as either bench or floor models. It is of importance to state that in most cases delivery can be given from stock.

(*Continued at foot of next column.*)

Random Shots

In another letter to "Marksman" from America, Dr. Jim Mackenzie adds a postscript to say that a "doodlebug" is also a gasolene-driven railway car, apparently recently introduced in Ohio. So that's settled at last!

* * *

With everyone's thought and energies being directed in more serious channels, the annual crop of schoolboy howlers has been unusually small this summer. Among the few that have come to light, these seem to shine the brightest.

Asked to give an example of a collective noun, Tommy promptly wrote "Philatelist."

In a paper on general knowledge, the pupils were asked to say what they knew of some notable composers, amongst them Wagner. "Wagner," wrote one youth, "was a man who composed a lot of operas in German. He dedicated one of them to Woolworth's, which he called "Tannerhauser."

* * *

Mrs. Malaprop went into a shop the other day to ask for some of those "ear plug things to dedicate noise."

* * *

After an all-night raid it was with mixed feelings that "Marksman" awoke after brief slumber to hear the newspaper boy cycling down the road singing at the top of his voice "O, lovely night." In spite of intensifying air activity, there are still thousands of people, thank goodness, who find the 7 o'clock getting-up alarm the worst of the lot.

* * *

"For complete relaxation from the nervous strain of war," reads an advertisement, "visit the Blank Turkish Baths, the only baths in London where the Vichy treatment is available." Somehow the two claims don't seem compatible with one another!

* * *

Not wishing to act as an unpaid publicist for the baths in question, "Marksman" has withheld the name, but it might be said that they are housed in an hotel in which foundrymen last year spent a few happy but expensive days. So expensive, in fact, that one Lancashire foundryman framed the bill which was presented to him there for a modest lashing of beer, so that his friends might see how much he had paid for it, otherwise they might not believe him!

* * *

Général de Gaulle's newspaper "France" contained a somewhat cryptic announcement—*"tCHAd, n'est pas de jeu" a dit M. Laval qui est Auvergnat.* It has puzzled a good many English readers. On translation it reads: "Pshaw!" says M. Laval, "Tchad is only 'a chip,'" but M. Laval is an Auvergnat. To a Frenchman this implies a person without a country, the current phrase being "un Auvergnat, il n'a pas de pays."

* * *

To finish on a really cheerful note.—Said one facetious gentleman, looking over the shoulder of his more serious friend, who was deep in a crossword puzzle, "Let me have a look at it. See, 50 across and 40 down, what's the answer to that one?"

The crossword enthusiast could neither find the number of the clue nor think of the answer, which was, of course, "German bombers."

"MARKSMAN."

Trends in Cupola Practice*

By DONALD J. REESE

Twenty years ago little was known about the metallurgy of cast iron, little was known about the physical properties, in fact very little was known about testing cast iron. The tensile strength of cast iron was then of the order of 9 tons, but during the Great War was stepped up to 15½ tons per sq. in. Only ten years ago a maximum of 18 tons per sq. in. tensile was thought to be adequate.

To-day, a first-class foundry can produce 27 and in the future it may be 35 or even 45 tons per sq. in. iron. In fact, both of the latter figures have already been attained. It is not intended to infer that the tensile strength of cast iron is of paramount importance, but as many other good qualities, such as compression strength, impact resistance, modulus of elasticity, etc., improve as the tensile strength improves, the term "tensile strength" simply serves as a definite yardstick to evaluate quality.

Methods of Melting Cast Iron

The above is a method of saying that whatever may be the quality demanded, the cupola can probably respond. It is not inferred that other types of melting media are without merit, for such is not the case. The common product of the cupola, cast iron, is also produced in electric furnaces, crucibles, air furnaces, open-hearth furnaces and various combinations of furnaces.

It is not necessarily true that the large tonnage foundry is a cupola shop, for roll foundries produce an important tonnage of cast iron melted in air furnaces. Again, a small foundry, when suitably located and catering to a specific type of business, may use an electric furnace.

No one type of melting furnace has proved superior to all others in producing a quality product, for what one producer has accomplished in one type of furnace, another producer has accomplished with equal facility in an entirely different type of furnace.

The cupola can be regarded as a high-speed or large-tonnage melting unit, for what other type of furnace can melt 500 tons in one day or deliver 5, 10, 20 or 30 tons per hr. continuously, for as many hours as one requires? Because of these two outstanding qualities of "speed" and "tonnage," one is quite likely to overlook the fact that this furnace is also quite "flexible" or "versatile."

Cupola Charges

If a foundry is operating a 72-in. dia. cupola, it is quite likely to be using a 3,000- or 4,000-lb. iron charge, but it could use a 1,000-lb. charge. If it is operating a 36-in. cupola, it is probably using an iron charge weighing in the neighbourhood of 1,000 lbs., but this size of cupola would work equally well with charges of 250 lbs.

If there is a special job to make that does not tie in very well with the weights of the cupola charge, the management either holds up the production of the job until there is more work of a similar nature or it goes ahead with production and disposes of whatever extra metal has been melted in some other job that may be able to take it or the over-iron is pigged. As a matter of fact, the cupola is probably flexible enough to be adjusted to suit the requirements of the jobs to be made and the simplest method is to alter the weights of the cupola charge accordingly. In other words, one probably could use a charge weighing only half or even a quarter of the present charge and attain satisfactory cupola performance. The author has operated 72-in. cupolas with 1,000-lb. iron and 120-lb. coke charges, taking off three charges at the beginning of a day's run to meet a high-strength iron specification in a foundry ordinarily making 13.5 tons tensile-strength iron.

Some types of furnaces are given credit for an outstanding ability to salvage the waste materials of industry, such as borings, turnings, etc., but again from personal experience no one type of furnace is superior to all others. One need only look over the yard in any roll foundry to realise that the air furnace contributes its share to the salvage operations of the foundry industry, for what other type of furnace can compete with it in salvaging scrap iron rolls from the rolling mills? Even after these rolls are put under the "drop ball" some of the unbreakable chunks may weigh 3 or 4 tons.

Briquetted Borings

There is no apparent reason which would rule out the use of a charge of 100 per cent. of briquetted borings except dependability and working out a practical cycle in the melting department of the foundry. One Eastern foundryman uses a cemented briquette made up of 18 lbs. of borings and 2 lbs. of cement. Ten per cent. of the cupola charge are briquettes and the product of the foundry is textile machinery. It is not certain that it requires 2 lbs. of cement to bind 18 lbs. of iron borings nor is it certain that there is sufficient economy involved in this type of briquette to make the salvage operation generally attractive, but the fact that it is being successfully carried out in the textile field where casting sections are light and machinability problems are likely to be acute is of sufficient interest to warrant mention here.

One cupola operates with a charge consisting almost of 100 per cent. of coiled wire rope, not halved or quartered but charged into the cupola in full coils weighing about 150 lbs. each. During 1939, a reputable Mid-Western foundryman experimented with charging loose heavy steel turnings into the cupola, not briquetted and not pressed into bundles or put in containers. More than 100 tons were used, and it is likely that several times this amount will be salvaged during this year.

Cupola Not Limited to "Average Quality Cast Iron"

It is not uncommon to find that the average person believes the cupola is limited to "just an average quality" of cast iron and it might be of value to point out a few uses of the cupola which might serve to broaden one's thinking in terms of its suitability as a melting medium. One of the first alloy steels developed was Hadfield's manganese steel, frequently referred to now as austenitic manganese steel, containing 10 to 14 per cent. manganese. This steel was made by adding molten ferro-manganese to an ordinary low-carbon steel made in the Bessemer converter. The ferro-manganese was melted in a cupola. This method produced an excellent quality of manganese steel, but the manganese losses encountered in remelting manganese steel scrap in acid-lined furnaces made it a more expensive method of production than to do the job in basic-lined furnaces, so the usual method of production to-day is a straight melting in basic-lined furnaces. However, it is well known that few elements are more difficult to handle in acid-lined furnaces than manganese, yet the cupola played a major part in making manganese steel by melting ferro-manganese. On a recent visit to a manganese steel producer's plant, equipped to produce either by melting in a basic-lined furnace or in an acid-lined furnace and a cupola, preference was given to the latter method.

Melting Non-Ferrous Metals

Metallic metal losses in melting non-ferrous metals, especially those containing zinc or lead, are likely to be quite high, or at least are an important factor in determining casting costs, yet the cupola is used to melt copper, bronzes, including those containing as much as 10 per cent. lead, and brasses containing up to 5 per cent. zinc.

High Alloy Castings

In the field of ferrous metallurgy, cast irons containing up to 25 per cent. chromium, 20 to 40 per cent. nickel, 11 to 14 per cent. silicon are being produced in cupolas. In other words, if the cupola is a good melting possibility when such elements as manganese, silicon, copper, tin, chromium, lead, etc., are present in amounts of 10 per cent. or more, it does seem reasonable to assume that it is quite versatile and its full possibilities in the ferrous field are nowhere near fully explored.

"Oxidised Iron" Questionable

Those familiar with the Bessemer steel process know that it is a refining operation in which air is either blown through or over the surface of molten iron, removing silicon, manganese and carbon, and that the end product is steel and not "oxidised iron." Having had some experience with the converter steel process, the author has been unable to get very much excited when he occasionally hears the description "oxidised iron" in connection with the cupola product. There are so many protective elements in cast iron—silicon, manganese, carbon—that what is more likely to happen is that the cupola has produced a metal lower in these elements than is suitable for the class of work rather than that it has produced "oxidised iron."

Melting Losses

In the cupola melting process, changes do take place in the chemistry of the iron, some because fuel and metal are in intimate contact and others because of the furnace characteristics. There is an increase in carbon and sulphur and a decrease in silicon, manganese and iron.

The actual overall melting loss of the cupola is close to 2 or 3 per cent. The commonly used figure of 5 per cent. includes the non-metallic material weighed in as part of the iron charge, metal losses through the slag hole and metal spattered around the foundry.

Silicon and Manganese

Silicon losses are generally of the order of 10 per cent. of the amount of silicon charged, but the actual losses vary from 5 to 30 per cent. Silicon losses are less with preheated air than with room temperature or outside temperature air. They are less with low-silicon irons than with high-silicon irons.

When the charge includes concentrated silicon alloys, such as silvery pig, silicon briquettes or ferro-silicon, silicon losses are least when these materials are concentrated in one spot in the charge and when large chunks are used. For example, if four charges be tapped into one ladle, and it is necessary to add 20 lbs. of 50 per cent. ferro-silicon to each charge, the silicon loss would be least if one 80-lb. chunk were added on one of the four charges and greatest when 20 lbs. on each charge were added with pieces weighing one pound each.

Manganese loss generally figures at 20 per cent., but the actual loss will vary widely—more widely than silicon.

Sulphur

The sulphur increase in cupola melting varies from 0.01 to 0.05 per cent. The sulphur increase is less with a high sulphur content in the charge than with a low content. Sulphur increase is more with steel-containing charges than when no steel is used. The more the steel in the charge, the more the sulphur increase. The more the surface area of the steel the more the sulphur

* Extracted from the August Bulletin of the American Foundrymen's Association. The author is metallurgist, International Nickel Company, New York City.

increase. Thus, a cupola charge containing 60 per cent. steel rails would show a lower sulphur pick-up than if the same quantity of sheet steel were used.

It is not practical to try to reduce sulphur in the cupola, but the amount of sulphur pick-up can be held down more in an operation using 100 lbs. of slag per ton of iron melted than in one using only 30 or 40 lbs. of slag. The higher manganese content irons are likely to show a lower sulphur increase than the lower manganese irons.

Undoubtedly, foundrymen give sulphur more attention than the importance of the element warrants. It is probably true that a low-sulphur iron makes a better grate bar than a high-sulphur iron, but in general most of the good properties of cast iron are not seriously affected by the sulphur content. However, specifications are specifications and they should be met or the specifications should be modified to suit normal sulphur ranges. In any event, ladle desulphurisation may be used and the specifications met thereby.

Carbon

A cupola charge containing 100 per cent. of a high-carbon pig-iron would probably show a loss in carbon, but the carbon of most cupola charges is less than 3.25 per cent. and may be as low as 0.75 per cent.

The amount of carbon that iron can hold in solution decreases with increasing silicon and phosphorus contents. Thus, if a low-carbon iron is sought it can be more easily obtained if a high silicon in the charge be used than by using a low-silicon iron.

The carbon increase in cupola melting increases with decreasing amounts in the iron charge. With 3 per cent. carbon in the charge the pick-up might be 0.25 per cent., while with an 0.75 per cent. carbon in the charge the pick-up might be 2.0 per cent. or more.

The various factors which influence the amounts of carbon that will be in the molten iron as tapped from the cupola are: (1) The amount of silicon and phosphorus in the charge; (2) the amount of carbon in the charge; (3) the characteristics of the coke used; (4) the amount of coke used; (5) the metal temperatures attained; and (6) the method of tapping the cupola.

The normal range of carbon in the cupola product is 3 to 3.50 per cent. The full range is from 2.0 to 3.8 per cent. Depressing the carbon range from 3.0 to 2.5 per cent. is relatively easy provided a suitable fuel and a suitable practice are employed, but depressing the range from 2.5 to 2.0 per cent. is more difficult.

When the cupola charge contains 20, 40, 60 and 80 per cent. steel, respectively, one should be able to produce irons of 3.25, 2.90, 2.50 and 2.15 per cent. carbon respectively.

Control of Carbon Range

Once a satisfactory carbon level has been established for the iron sought, then the important job is to control the carbon range around the desired level to the least possible spread. Most foundrymen think little of a 30-point carbon spread and occasionally it is as much as 100 points, or 1.00 per cent. carbon. This spread may be controlled within 10 points in excellent cupola practice. Carbon has a profound influence on the quality of the iron produced and, once the best carbon level for the product is established, every effort should be put forth to gain the utmost in carbon control. While many factors influence the various carbon levels attainable in cupola practice, the control of carbon at the desired level is largely limited to tapping variations.

As carbon is the most difficult element to control in cupola melting, it seems logical to expect that once operating details have been established that result in good carbon control, other variations will also be under good control. Do not forget that the cupola tender may have as much to do with the quality of the product as the chemist or metallurgist, and sometimes he has more.

It is possible that reference to extremely low carbons may be disturbing, and it may be thought that these carbons have very little interest to anyone dealing with cast iron. However, one section of the foundry industry has produced thousands of tons of cast iron in which the carbon content was as low as the lowest carbon mentioned, and in many instances the carbon was much lower. The roll industry is an example.

Importance of Accurate Weighing

It is good practice when all materials charged into the cupola are weighed accurately and, strange as it may seem, it is one of the most difficult jobs to have well done.

A few years ago, the cupola charge contained two metallic components, pig-iron and scrap iron, probably 50 per cent. of each, and the charge weighed, say, 4,000 lbs. Weighing errors were relatively unimportant, and the function of weighing was as much for inventory control and to let the foundry superintendent know when enough iron had been charged to pour off the floors as for any other reason. Today the cupola charge contains more than two components, actually as many as 12 in some foundries, and the charge probably weighs 2,000 lbs. or less. Weighing is a matter of metallurgical control, and weighing inaccuracies, due either to men or equipment, have a direct bearing on the quality of the product.

Pouring Temperatures and Losses

The temperature of metal as tapped from the furnace is much less important than the pouring temperature. The author has witnessed metal being tapped at temperatures as low as 1,370 deg. C. and as high as 1,590 deg. C., and as far as can be ascertained, if metal at these two extremes of temperature were of identical composition and temperature at time of pouring, they would be equivalent in quality and in service.

When the pouring temperature of metal is low, it is true that the surface finish of the casting is superior to that where the pouring temperature is higher, and for these castings, where surface finish is of greatest importance, the pouring temperature should be controlled to give the best results. In machinery castings, where the surface is of little importance and where good physical properties or micro-structural control are paramount, then pouring temperatures should be in the higher ranges, generally above 1,425 deg. C. and sometimes as high as 1,500 deg. C.

It is not as easy as it sounds to pour metal into moulds at 1,425 to 1,500 deg. C., for metal temperature losses are generally more than one would think. These losses are due: (1) to the use of cold ladles; (2) to the use of ladles with light refractory linings; (3) to shanking as much as three or four times; (4) to additions of cold materials to the ladle, and (5) returning ladles to furnace with metal in them.

Losses between the cupola spout and the mould are usually between 110 and 220 deg. C., sometimes a little less than 110 and occasionally more than 220 deg. C.

Most foundrymen believe they melt hot and pour hot, but it is quite likely that the metal temperature at the spout for the first few tons is not very hot, and the pouring temperature for the first few ladles is likely to be 80 deg. C. or more on the cold side of a good pouring temperature. The author asked a foundryman to check some temperatures with him a few months ago; it was a good foundry, and he checked his temperature with an optical pyrometer. He thought he was pouring at 1,425 to 1,480 deg. C., but the first three ladles were poured at 1,360 to 1,340 deg. C.

Cast-Zinc Forming Dies

"Metal Progress," in a recent issue, has some interesting notes on the composition of the zinc alloys used as dies in the light-alloy stamping trade. Most plants, states this authority, started out with dies for short runs (say 20 to 50 parts), and used one of the purer brands of slab zinc. One of the most popular is rather soft, but commends itself on the score of cheapness. Remelting obsolete or worn dies brings about contamination by iron from the pots, antimonial lead from the dies forming the punches, and aluminium from the general plant scrap, resulting in a rise of the casting temperature from 425 to about 510 deg. C. This is thought to be the cause of surface crinkles.

Zinc alloys, such as those developed for die-castings, are very much stronger, harder and tougher than slab zinc, and are capable of accurately forming 15 times as many stampings. Thus alloyed zinc is adopted when production increases. The alloys adopted in the U.S.A. are those detailed in A.S.T.M. specification B86-38T, alloy Nos. 21 and 25. The former has about 4 per cent. aluminium, 3 per cent. copper, and 0.05 per cent. magnesium. In the second case the copper is only 1 per cent. Successful re-use demands carefully controlled conditions in the die foundry. These alloys cast readily and satisfactorily at 425 deg. C. Exceeding this limit is detrimental, but by adhering to it rigidly an accurately reproduced surface requiring little polishing if the plaster of paris mould is well made results.

The note in "Metal Progress" states that German plants use 5 per cent. copper in zinc rather than aluminium, believing that this alloy is less damaged by normal contamination, but this is contrary to the usual notion that aluminium reduces scour on the pots.

Heat-Resisting Steels

A Paper on "Some Effects of Composition and Heat-Treatment on the High-Temperature Rupture Proportions of Ferrous Alloys" was presented by R. H. THIELEMANN at a meeting of the American Society for Testing Materials, held recently at Atlantic City, New Jersey.

The Paper deals with the high-temperature rupture properties of ferrous alloys as determined by sustained load-rupture testing. The general problem of the susceptibility of high-temperature materials to failure by intergranular cracking is discussed and rupture test results for 15 representative alloys are presented. These results indicate that the susceptibility of the various alloys to failure by intergranular cracking at elevated temperatures varied with the type of the alloy as determined by its composition. It is shown, from tests of fairly long duration, that the chromium-bearing ferritic-type alloys are apparently the only ones that are not susceptible to failure by intergranular cracking at elevated temperature.

A system of evaluating the composition of an alloy in terms of a numerical chromium equivalent value is presented. It is pointed out that both the type of an alloy and the relative susceptibility to failure by intergranular cracking can approximately be determined by its chromium equivalent composition.

The effect of increased grain size on the high-temperature rupture strength of a low-carbon 3 per cent. Cr steel is shown. The relation of micro-structure resulting from heat-treatment to the high-temperature rupture properties is considered, and a particular illustration of this effect is shown for a 5 per cent. chromium, 1.5 per cent. silicon, 0.50 per cent. molybdenum alloy.

Heat-Treatment of Malleable Iron

By R. J. COWAN*

Malleable iron is a material which owes its malleability to an extended period of heat-treatment. When first cast, it contains approximately 2.5 per cent. carbon, entirely in the combined form, so that the metal is extremely hard and brittle. During heat-treatment, this combined carbon is reduced by a process of graphitisation until, in the fully-annealed casting, but very little if any combined carbon remains. The carbon in fully-annealed castings exists as free carbon or graphite of distinctive form.

Industry is becoming increasingly aware of the fact that the heat-treatment of a high-carbon material of this kind can be modified to produce a great variety of materials which will have, in their various modifications, a wide range of physical properties. The vast extent of this field may be indicated when it is recalled that the common steels are classified on the basis of their carbon contents and owe their many uses to the specific properties that may be developed by heat-treatment.

There are to-day a rapidly increasing number of uses for these materials. Certain kinds have been extensively developed for particular purposes, and these are finding wide acceptance among various users. Other materials are being developed and, without doubt, will find a place in suitable applications. It is the purpose of this Paper to call attention to some of the things that have been done and to suggest other fields of development that appear promising.

Field of Pearlitic Malleable Irons

It is customary in the manufacture of certain types of pearlitic malleables to modify the usual annealing treatment to produce the type of material desired. This consists, as a rule, of changing the treatment during the second-stage annealing operation. It is assumed that all are familiar with the usual type of annealing cycle which embraces a first-stage treatment at high temperature and a second-stage cooling to complete the cycle. The pearlitic material is removed from the furnace after the completion of first-stage annealing, and after cooling is then subjected to a special treatment at or below the critical temperature range for a period of time sufficient to obtain the special properties desired in the metal. As a rule, it is possible, by means of a microscopic examination of the metallographic structures obtained, to identify those that experience has shown will produce the desired physical characteristics.

Where there exists a microstructure showing a background of carbide structure with temper carbon nodules dispersed throughout, and around each of these nodules there appears a white area in which the carbon is lower than in the body of the metal, it has been found to be desirable to limit this white area to very small regions and preferably to eliminate it entirely. Experience has shown that a pronounced white area around these nodules affects the machinability of the metal and makes it more difficult to cut.

There is an advantage that comes from having the carbide in the form of spheroids when the metal is to be subjected to heat-treatment, because in this form it will dissolve most readily when heated to temperatures suitable for hardening. When a metal of this type is hardened by quenching from a high temperature, the structure becomes quite different in appearance under the microscope. Spheroids of carbide are still present in the hardened structure, and experience in other fields has indicated that a structure of this type has superior wearing qualities. The presence of these spheroids which, of themselves, are extremely hard, embedded in a hardened steel structure, denotes a type of structure which has been proved to provide the very best wear-resisting surfaces in many different kinds of operations. In certain applications where resistance to shock is a big factor, it has been found that the presence of spheroids of carbide in the case-hardened structure is the type that will give the best service under these trying conditions.

* Surface Combustion Corporation, Toledo, Ohio.

Hardening Operations

To develop a wear-resisting surface, it is necessary to heat the metal to a temperature where the carbon will be brought into solution in the iron in sufficient amounts to provide hardening when quenched in water or oil, the procedure in this respect being similar to that used in the hardening of steel. The abundance of carbides in the pearlitic malleable structure is not all required to provide the necessary degree of hardness. Consequently, it is not necessary to soak this material at high temperature for a long time to ensure the solution of sufficient carbides to provide the requisite hardness. The excess carbides, when present as spheroids, impart wear-resistance in the manner described.

This Paper in its original form, as presented to the American Foundrymen's Association at the Annual Meeting in Chicago, carried a number of excellent photomicrographs. If the results disclosed in the summary are easily reproducible under practical conditions in this country, the cyanide surface-hardening for wear-resisting parts might with advantage be replaced.

Recent studies of the hardening operation with high-carbon steels of various types have brought forth a method of procedure that is markedly different from that of the usual operation. Instead of quenching directly into cold water or oil, the metal is quenched from the hardening temperature into a liquid bath that is maintained at a definite temperature. It has been found by this procedure that definite soaking times are necessary to accomplish the full degree of hardening that is possible at each temperature. In this way, a definite hardness can be obtained by maintaining the required temperature for a definite time. Furthermore, the hardness is found to vary with the temperature of the quenching bath, the high hardness values being obtained by a long soaking at comparatively low temperatures. This process is known as "austempering," when applied to steel, and has received a great deal of attention and publicity during the past year.

The results obtained are markedly different from those of the usual quench and temper method heretofore employed. By the earlier method of procedure, the steel was quenched in cold or warm quenching media, which produced a drastic hardening that was too great for most applications, so it was necessary to reheat and soak for some time at a low temperature to relieve this condition and obtain the desired degree of hardness. The results obtained by the austempering method show a type of hardness that combines a certain degree of toughness without brittleness and, accordingly, seems to possess certain inherent elements of superiority. This method is being used in a number of industrial applications.

Some bars of iron were subjected to a heat-treatment of this kind to observe the results obtained. Bars of hard iron were given an annealing treatment sufficient to complete first-stage annealing. They were then quenched from this temperature in a bath of molten lead which was held at various temperatures. After soaking for one hour at a temperature of 537 deg. C., the hardness was found to be 40 Rockwell C. The microstructure shows a number of carbide spheroids and the complete absence of white ferritic areas around them. A greater degree of hardness can be obtained by quenching in lead that is held at a lower temperature, and when the metal was quenched at a temperature of 343 deg. C. and held at this temperature for one hour, the hardness was found to be Rockwell C 49. Close examination of the microstructure indicates that spheroids of carbide are still found to be present within the hardened structures.

These results are sufficient to illustrate the possibilities of a heat-treatment of this kind. Intermediate values may be obtained by soaking at intermediate temperatures. There is no danger of soaking for too long a time at temperature since it has been found that the structure corresponding to that temperature is reasonably constant after it has once been obtained. The only limitation is that of a minimum time which must in all cases be exceeded to obtain full transformation.

Summary

Based on the results of the present investigation, it may be stated that:

(1) A method of heat-treatment is proposed which may be suitable for the processing of certain machine parts.

(2) Constant hardness values may be obtained that depend only on a definite temperature control of a quenching bath.

(3) An ideal type of structure is obtained in this manner which will possess superior wearing characteristics.

(4) Proceeding in this manner, a hardened structure may be confined to the surface areas of a heavy section, while the remainder of the piece will receive a heat-treatment that will have a toughening effect.

Leaded Steels

At the last spring meeting of the Chicago Section, American Institute of Mining and Metallurgy, DR. O. E. HARDER, of the Battelle Memorial Institute, discussed recent work on leaded steels. Lead is added to the ladle in the form of fine shot to give a lead content of 0.2 per cent. to the steel. The lead is dispersed so finely that it is not detected by ordinary metallographical methods. A great many tests on many kinds of steel and under many conditions of heat-treatment and hot- and cold-working indicate that the presence of lead has little effect on the physical properties of the steel except to make it more machinable. Machinability seems to increase with increasing lead content, but an upper limit is soon reached where it is no longer possible to attain the fine dispersion necessary for good results. Phenomenal increases in speed of machining were obtained by the addition of 0.1 to 0.2 per cent. lead; increases of 25 per cent. were normal and several of 200 to 300 per cent. were reported.

The effect of lead additions may be superimposed on those of other addition agents. For example, addition of lead to high-sulphur screw stock, which would not permit higher sulphur content because of its harmful effect on strength, will materially increase its machinability without decreasing its strength. Similarly, lead makes chrome stainless more machinable without affecting its corrosion-resisting properties. These steels are receiving wide attention by the fabricating industries; around 58,000 tons of leaded steels have been marketed in the United States.

Stress Corrosion

VALUE OF ACCELERATED TESTS

In the course of a Paper on "Acceleration of Corrosion by High Constant Stresses," published in "Metals Technology," MR. E. H. DIX deals with the process of stress corrosion, regarding which he states that there are many variables, of which only a few can be evaluated in any particular case. When the interacting effects of the various factors are considered, the process of stress corrosion is understandable. First, there must exist in the alloy a susceptibility to selective corrosion along more or less continuous paths as, for instance, at the grain boundaries. This susceptibility is present when the internal structure of the alloy is microscopically heterogeneous and the phase forming the continuous paths is anodic in the specific corrosive medium to the areas composing the major part of the structure. Second, there must exist a condition of high stress acting in a direction tending to pull the metal apart along these continuous paths. If these two conditions exist simultaneously and the metal is subjected to a corrosive environment producing the specified potential relations, corrosion will start along the anodic paths. This will produce a concentration of stress at the bottom of the notches so formed. As the stress increases, fissures will begin to develop, destroying any protective film and thus exposing fresh anodic material to the corrosive medium. Corrosion will proceed more rapidly and at the same time the stress will increase at an accelerated rate, especially if the material is subjected to a high external load. These mutually accelerated actions will continue at an increasing rate until the metal fails.

One of the curious aspects of stress-corrosion failures is the wide difference in the time required for failure, which varies from a matter of minutes to many years. There are several reasons for such wide variations. First, there is an incubation period in many alloys during which structural changes are occurring. Second, a long time may be required before corrosion proceeds to the extent that the rapidly accelerated process begins to act. It is obvious that the more severe the corrosive conditions and the higher the initial stress, the sooner this process will start.

Finally, failure of an alloy in accelerated stress-corrosion tests does not necessarily indicate that stress-corrosion failures are to be expected with it in practice. Experience has shown that in the absence of high internal stresses or excessively high stresses from external loading (often caused by faulty engineering), stress-corrosion failures are not encountered in service. This is even true of many alloys which, under the severely corrosive conditions used in accelerated tests, show an increase in their rate of corrosion when subjected to high stresses.

What, then, is the value of accelerated tests? First, they enable the metal producer to determine which alloy compositions are markedly susceptible to stress corrosion under severely accelerated test conditions. Second, for alloys that are found to be susceptible, the manufacturer may determine the fabrication conditions required to reduce or eliminate this tendency. Third, accelerated tests are useful as a means of technical control, to ensure that the proper fabrication procedures are being consistently employed. Fourth, by studying the susceptibility to stress corrosion in accelerated tests, in comparison with that of alloys in general commercial use which have long and satisfactory service records, a decision can be reached on the use of any specific alloy composition for a given application.

It is important to recognise that many alloys that are subject to acceleration of rate of cor-

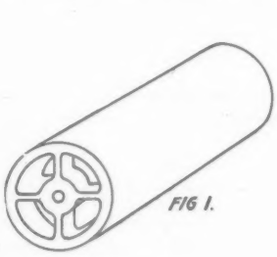
(*Continued in next column.*)

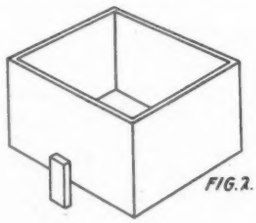
Some Jobbing Foundry Experiences—VI

By "TRAMP"

A casting of a roller such as Fig. 1 is often made by full pattern and core-box. This method is ideal when a considerable number are required, but jobbing shops are usually called upon to supply single castings which invariably differ in length. Thus the minimum of pattern work is supplied and ways and means must be adopted to meet the different circumstances. One requisite for this work is a number of middle-part moulding boxes about 6 in. deep. These can be used to mould rollers of varying depth by the addition of more boxes, the method of registering which is shown in Fig. 2.

The pattern equipment required is a cross-





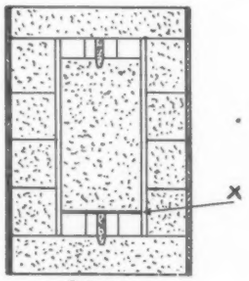
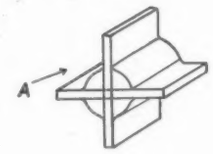


FIG. 3.



piece as at A, Fig. 3, and a shallow ring as B. Fig. 4 is a section of the finished mould. The bottom box is first laid down and filled with sand, when the cross-piece is bedded down. The ring is then centred on this and the first middle box placed in position and the outside rammed. The cross pattern is then withdrawn and a centre core (which has either been tarred or saturated in paraffin to resist the damp) placed in the core print. Slates indicated by a cross are now used to cover this portion of the mould and the interior is rammed on these. The pattern is then "drawn through" and mid-boxes used until the correct height is obtained, when the cross is again placed in position. A top is rammed and lifted off, the pattern withdrawn and a runner cut into one of the arms and riser placed opposite. A core is inserted in the top print, the top is placed on and clamped, and the job is ready for casting.

(*Continued from previous column.*)

rosion under high constant stress and corrosive conditions possess other valuable characteristics, often including high resistance to general corrosion. Such alloys have been extensively used commercially with satisfactory results for many years. It is clear, therefore, that there is nothing mysterious about susceptibility to stress corrosion; it is just another physical characteristic, which should be considered in the same light as such properties as endurance limit or yield strength in the selection of an alloy for a given application.

Magnesium and Its Alloys

The May-June issue of "Foundry Practice and Foseco News," the house organ of Foundry Services, Limited, of Long Acre, Nechells, Birmingham, 7, contains an interesting article on the history, occurrence, properties and uses of magnesium, followed by some practical notes on the making of castings in alloys of this metal. A second short article shows how the production of defective nickel castings was eliminated.

Cast-Iron Piston-Ring Pots

NEW PROVISIONAL SPECIFICATION

The Air Ministry has issued a new provisional specification, D.T.D.413,* for sand or chill-cast cast-iron piston-ring pots. Some of the more important clauses are appended.

Chemical Composition.—(*a*) The chemical composition of the material of the pots shall be (per cent.):—Total carbon, 3.4 max.; combined carbon, 0.6 min., 0.9 max.; silicon, 1.6 min., 2.4 max.; sulphur, 0.12 max.; phosphorus, 0.6 max.; manganese, 0.5 min., 1.5 max.; nickel, 0.25 min., 1.0 max.; chromium, 0.25 max.; copper, 0.2 min., 1.0 max.; molybdenum, 0.5 min., 1.2 max. (*b*) The complete analysis of the material of the pots shall be supplied to the Inspector. (*c*) The sample for chemical analysis shall be taken from one of the pots selected for the mechanical tests. Before samples for analysis are taken from any pot, the pot shall be turned down at the end which is to be sampled, to a diameter approximately equal to that of the rough machined rings which are to be made therefrom. The drillings or turnings for chemical analysis shall be taken from the metal which remains after this machining has been carried out. As an alternative the pot may be drilled parallel to its longitudinal axis in the centre of the thickness of the casting with a drill whose diameter is approximately equal to the thickness of the finished ring. The whole of the sample after drilling or turning shall be sieved in a 30-mesh sieve. The parts which pass the sieve and the parts which do not shall be weighed and proportionate parts taken for each determination.

(*d*) If any sample fails to satisfy the chemical composition specified in paragraph (*a*) above the Inspector may make such arrangements with the manufacturer for increased testing as may be considered necessary.

Elasticity Test.—A test ring shall be machined from the pot to a thickness of not less than $\frac{\text{dia. (uncut)}}{34}$ and a piece cut out of the ring so as to leave a free gap of not less than 2.75 t and not more than 3 t (t = thickness of the pot). The width (b) and the radial thickness (t) shall then be determined and a diametral load (Q_1 lb.) sufficient to close the gap to less than 0.25 t shall be applied. The change in width of the gap (δ_1) and the mean external diameter (d) of the closed ring shall be measured and shall be such that En, when calculated from the following formula, is not less than 16.5 × 10^{-6} lbs. per sq. in.:—

$$En = \frac{5{\cdot}37\left\{\frac{d}{t} - 1\right\}^3 Q_1}{b\delta_1}$$

(*Continued on page* 162.)

* H.M. Stationery Office, York House, Kingsway, London, W.C.2 (price 6d.).

Non-Ferrous Applications of Top-Pouring Methods*

By ARTHUR K. HIGGINS

The foundry from which this Paper emanates has been confronted from time to time, as are most shops, with castings the design of which is such as to cause considerable difficulty in the choice of gating and risering methods. A number of such castings had been encountered at about the time of the presentation of the Paper by Brisbois and Cartwright.†

Contrary to the views expressed in that Paper, considerable trouble had been experienced with such alloys as 80:10:10, 75:10:15 and 88:8:4, rather than with the alloys having higher shrinkage. Difficulty had been experienced with a group of large 80:10:10 bushings of from 500 to 1,000 lbs. in weight, which were of sufficient diameter and length to prevent adequate feeding of central portions when cast with the axis in either a vertical or horizontal position. While feeding might have been secured by an increase in pouring temperature, it was not felt that the added temperature was desirable from the standpoint of obtaining the desired physical properties. The timely presentation of the Paper mentioned above offered the solution to many of the problems then current.

Purpose

It is not the purpose of this Paper to retrace the work done by Brisbois and Cartwright, but rather to make more feasible the application of their methods to general foundry work, by the elimination of some of the practices that may have caused difficulty in the smaller foundries that are confronted with the same problems.

Points in the method that caused the greatest hesitation in applying the practice to the author's foundry were:—(*a*) The heavy risers shown; (*b*) the use of synthetic sands to resist erosion by falling metal, and (*c*) the added cost of moulding runner boxes and strainer gates for medium and small castings. The principal work done on top gating has been in attempting to circumvent these difficulties.

Preliminary Tests

The first steps in the application of gating through risers were the production of a number of test castings which were intended to show: (*a*) the effect of impact of falling metal on dross formation; (*b*) the effect of rate of pour on shrinkage and feeding; and (*c*) the ability of natural sand moulds to withstand the cutting action of falling metal. It was felt that the first two questions could be answered by casting simple sticks moulded on end, and using a high-shrinkage, drossy alloy. The results of some of these tests are shown in Fig. 1, which represents the upper halves of three 3-in. by 18-in. manganese bronze sticks.

The casting at the left in Fig. 1 was poured from the top through a single ¼-in. hole in a strainer core, and was filled in 115 sec. with metal at 1,065 deg. C. The mould was made of No. 1 Albany sand, and no precautions were taken to prevent cutting, except to see that the mould was vertical. Careful inspection of this casting showed that while shrinkage was small (2½ in.), dross was entrapped by the rising metal near the midpoint of the casting.

The centre casting in Fig. 1 was moulded in the same way, except that the metal was introduced through ten ¼-in. holes in a strainer core at the top of the casting. The casting was filled in 15 sec. with metal at 1,065 deg. C. Inspection shows that this casting, while having slightly deeper shrinkage (3¼ in.), is sound throughout the rest of its length. The conclusion drawn from the action of these two castings, and others like them, was that excessively slow pouring rates, while reducing shrinkage somewhat, were not desirable from the mechanical standpoint of entrapping dross and dirt. Such slow pouring reaches a critical point where the rate of pouring is slow enough to allow the zone of turbulence from the falling metal stream to enter the zone where interlacing metal crystals are forming, and the resultant entrapping of dross and accidental dirt may cause difficulty with any type of metal.

A stick casting of the same type was poured by the conventional method of bottom gating, with a choke in the gate a little removed from the point of entrance of the metal into the mould, to allow the metal to enter quietly and without turbulence. This casting, shown at the right in Fig. 1, exhibits open shrinkage to a depth of 5½ in. and shrinkage porosity through nearly 9 in. of the 18 in. length.

As a result of these and similar tests, it was concluded that:—(*a*) The foundry could use top or riser pouring for castings at normal pouring rates, and excessively slow rates were not only unnecessary but dangerous; (*b*) it could pour the common brasses and bronzes in this manner without great fear of drossing in simple castings, and (*c*) it could materially decrease the size of risers without having shrinkage extended into the castings. It was also indicated by these tests, but not shown in the illustration, that a rather rough surface may result at times in castings of aluminium bronze or manganese bronze. This makes gating through risers impractical for these alloys, even in the simple castings, where it could otherwise be used, unless outer appearance is not important, as in fully machined castings.

FIG. 1.—UPPER HALVES OF EXPERIMENTAL MANGANESE-BRONZE STICK CASTINGS.

FIG. 2.—METHOD USED TO CAST 80:10:10 BUSHINGS IN DRY SAND.

Bushings

The first foundry application of this method was in the casting of large bushings of the type shown in Fig. 2, ranging in weight from 600 to 1,000 lbs. Normal practice had been to cast these bushings with the axis horizontal, to place a riser at each end of the bushings, and to supply the metal through gates at the bottom. Frequent losses were encountered in the larger sizes, due to shrinkage along the parting line. Bushings cast with the axis vertical and gated through the bottom were also subject to this type of shrinkage.

The first top-gated bushings were poured in dry sand with the use of rather elaborate runner boxes designed to supply the metal through a number of risers by means of skim gates. It has been since found that green sand is suitable for the smaller sizes, if precautions are taken to absorb the first shock of falling metal. A practice is made of placing a small flat stock core against the bottom of the pattern at the point where the falling metal will strike when the mould is completed. The first metal entering the mould forms a pool that cushions the fall of the remaining metal.

The limitations in using green sand for bushings seem to be the same as for castings with conventional gating, provided the core-sand pieces are placed as described in the previous paragraph. Where such cores have not been used, there have been occasional losses due to sand in the castings, when the casting was more

D.

* Paper delivered at the Chicago Convention of the American Foundrymen's Association. The author is associated with the Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

† Brisbois, C., and Cartwright, A. E., "Risers or Gates for Some Special Non-Ferrous and Alloyed and High-Test Iron Castings," Trans.A.F.A., vol. 46, pp. 219-256 (1938).

than 20 or 30 in. deep. The sand used for all green-sand moulds is the same as that used in the preliminary castings (No. 1 Albany), and has a green strength of about 4 lbs. per sq. in. and a permeability of 18.

Bushings of the larger sizes are normally made in dry sand and without special precaution. The one illustrated in Fig. 2 is an example. In all cases, metal is supplied to the mould cavity through a runner box. Runner boxes for the larger castings are built in green sand, but are commonly supplied with flat stock core bottoms, through which holes are filed to admit metal to the mould cavity. Care is taken that the holes are directly over the casting so that the metal may have an unimpeded fall.

Centrifugal Pump Impellers

The second application of top-pouring, and perhaps the most important, is in casting centrifugal pump impellers, two of which are shown in Fig. 3.

The bulk of these castings are made in green sand with a cereal-bonded core. The metal, usually 90:10 or 75:10:15, is dropped on to the upper surface of the core, which is intricate, but usually rather massive. Impellers of the size shown, which weigh about 300 lbs., may be cast in dry-sand moulds.

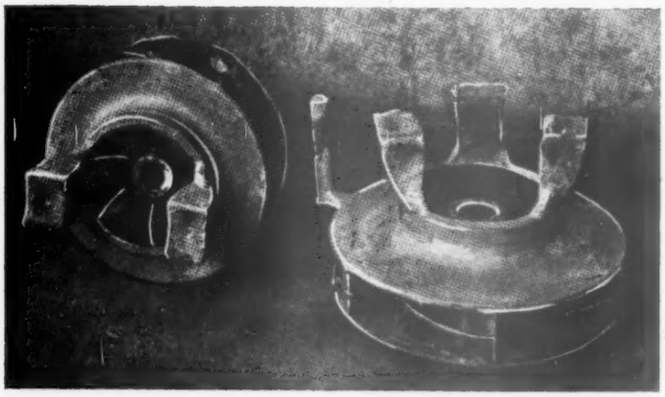


FIG. 3.—CENTRIFUGAL PUMP IMPELLERS OF 90:10 ALLOY, WHICH WERE POURED THROUGH RISERS.

Losses experienced in these impellers, when cast by conventional methods, were due to several causes:—(*a*) The heavy outer hub section was subject to shrinkage, particularly on the bottom side where it was cut off from feeding by the relatively thin vanes; (*b*) in the smaller impellers, having heavy central hubs, the vanes often cracked away from the hub unless excessive pouring temperatures were used; and (*c*) excessive pouring temperatures caused a great deal of trouble by burning in cores and, since some of these castings have only ¼-in. opening for core removal, fettling costs were high.

Normal gating practice for this type of casting was the use of a loop-gate attached to the upper edge. If the impeller was large, two such gates were used and the castings were poured "double up." Present practice is as shown. Two or three risers are connected to the outer hub and a small flow-off is cut from the outer edge of the mould to indicate the height of metal in the mould. If the centre hub is excessively heavy and likely to cause cracking of the vanes, the upper portion of the centre core is cut off and a full riser is placed at that point.

Metal is supplied through a pre-fabricated, core-sand runner box, and is poured into all risers. Pouring is gauged by the flow-off and is stopped while there is room in the risers for all of the metal in the runner box.

There has been only one cause of trouble that can be ascribed to top-pouring in this type of casting, *i.e.*, in the possibility of cutting out sand from the upper face of the mould where metal bounces off the core. In every case, an examination of the surface of the casting has shown that the mould was not rammed as hard as it should have been, since this cutting action is associated with small swells in the casting.

The pouring temperatures for these castings are decreased by the top-pouring practice, as was the case with bushings. Where the normal pouring temperature for 90:10 bronze, with the old style of gate, was between 1,175 and 1,230 deg. C. for castings of 20- to 50-lb. weight, the present practice is to pour these castings at from 1,120 to 1,150 deg. C. The lower pouring temperatures permit running of the extremely thin edges of vanes and still maintain a good metal structure and good physical properties.

Pump Casings

The casing shown in Fig. 4 is a typical example of a type of casting that has caused a great deal of trouble because of pinhole leakage, almost invariably due to shrinkage. The many section changes and the frequently severe test specifications have combined to cause trouble in many cases. These pump casings have varied so in size and complexity that no entirely standard method of conventional gating could apply. In general, however, the method has been to connect several gates to the lower parts of the casting and to fill these through a common runner box.

Adoption of the new system has resulted in definitely smaller losses, and in improvement in accepted castings. These castings are all made in dry sand and are normally moulded in the position shown. A riser is attached to each flange at a point where it will best feed the heavy sections. The metal is poured into the risers through a green-sand runner box and is allowed to fall freely into the mould without great regard for the mould and core surfaces. There have been no indications of cutting-in, in cases even more severe than the example shown, where about 3,000 lbs. of metal fell into the mould before the rising metal covered the point of impact on the cores or mould.

Difficulties Encountered

While no insurmountable difficulties have been found in the application of top-pouring to foundry practice, certain factors inherent in the method must be noted. The first of these is the increased moulding cost resulting from the use of runner boxes for all top-poured castings. While complicated runner-boxes may be justified by large castings, the bulk of foundry work will not carry the extra moulding cost, although the castings made may be of much better quality. A personal solution to this problem has been the construction of core-sand runner-boxes that provide for almost all of the small castings.

The core box, and the cores made from it, are shown in Fig. 5. The core box is provided with ample draft so that the centre piece may be fastened to the bottom of the box. The cores

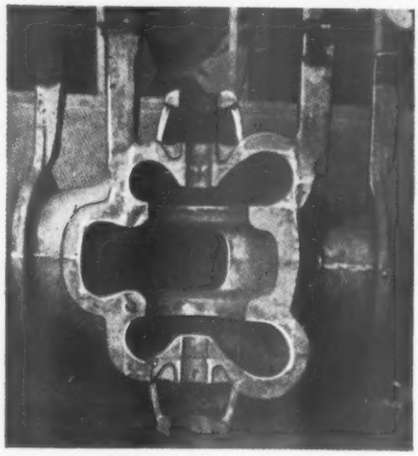


FIG. 4.—A 3,500-LB. PUMP CASING IN 85:5:5:5 ALLOY POURED THROUGH RISERS.

are made from any of a number of heavily-bonded core sands and are made in either of two sizes carried as stock. As may be seen from the illustration, the core box does not provide for the holes that admit the metal to the mould. These holes are cut by the coremaker while the core is still green.

These runner cores are carried in stock until they are too worn for further use. Normally they are re-blackened after each use, and serve from 6 to 8 castings before they must be discarded. It is the duty of the coremaker, assigned to any job, to see that there is a runner core in stock that will fit the casting on which he is working, or to make such a core.

It has not been the practice to use strainer cores to control the flow of metal to the mould, as it is felt that the use of such cores involves needless expense in setting and, in addition, creates a possible source of dirt or sand, particularly in the case of large castings. It would

FIG. 5.—CORE BOX AND CORE-SAND RUNNER BOXES FOR SMALL CASTINGS.

seem as valid to worry about the cutting of a strainer core by metal flow as to worry about cutting of cores within the casting, particularly when the strainer core must carry the weight of the column of metal above it, while the internal core carries only the buoyancy of its own displacement. It has been the practice so to proportion the core-sand runner-boxes for the small casting, or the green-sand boxes for larger castings, that the amount of metal supplied by the pouring basin is more than ade-

(*Concluded on facing page.*)

A New Heat-Treatment for Grey Iron*

By E. L. BARTHOLOMEW (Chief Engineer, United Shoe Machinery Corporation, Beverley, Mass.)

It has been generally known for a long time that cast iron, as cast, makes a fairly good bearing metal, but recent work has scientifically demonstrated that cast iron properly heat-treated makes a good bearing metal. The considerations of the wearing characteristics of grey cast iron have just in the past few years been entertained. For example, the motor-lorry engine cylinder-liner life has been found to be more than doubled in terms of miles of operation where a high-nickel austenitic iron is used in place of plain cast iron. Various heat-treatments have been devised which have increased the wearing properties of cast iron.

The heat-treating method described in this article is justified primarily by the marked improvement obtainable in physical and wear-resistant properties of cast iron. (U.S. Patent No. 2200765.)

The fine work and resulting literature of E. C. Bain, E. S. Davenport and associates, on the "austempering of steel" must be duly credited as the stimulating factor in this work. Interest in the austempering procedure led to the discovery that by a similar treatment of cast iron (that is, an interrupted quench) the same acicular structure or Bainite was evidenced, but in the case of cast iron the austenite was not fully transformed after normal holding time in the hot-quenching bath. Furthermore, the austenite was retained at room temperature indefinitely until subjected to either cold work or temperatures above the quenching bath temperature. It was also found that, unlike steel, it made no difference as to the rate of cooling from the bath temperature, the austenite still remaining.

The details of the heat-treatment are as follow:—

(1) Heat to 843 deg. C., hold at heat 15 mins.

(2) Quench to 265 deg. C., hold at heat 15 mins.

(3) Air cool to room temperature.

The percentage analyses of the irons used in this experimental work are as follow:—

	No. 53.	No. 54.	Mo iron.
T.C	3·35	3·35	3·25
Si	1·30–1·40	1·30–1·40	1·75
Mn	0·50–0·80	0·50–0·80	0·80
S	0·13–0·15	0·13–0·15	0·10
P	0·30 max.	0·30 max.	0·30 max.
Ni	2·00	1·50	—
Mo	—	—	0·50
Cr	—	0·50	—

The Brinell hardness of the No. 53 iron as cast is 220, but after the interrupted quench treatment it is 388. The rate of cooling from the quenching temperature appears to have little effect on the resulting microstructure.

The following shows the physical properties resulting from a treatment as outlined above on a molybdenum iron with analysis as given in the table: *As cast*—223 Brinell, 21 tons per sq. in. tensile strength, 44 ft.-lbs. impact. *Heat-treated*—341 Brinell, 33.7 tons per sq. in. tensile strength, 61 ft.-lbs. impact strength. The impact tests were made on a Charpy type machine using an unnotched bar 1.125 in. in diameter broken on 6-in. centres.

The heat-treated iron is readily machinable up to 300 Brinell hardness. Because of the small amount of distortion the part may be machined before heat-treatment where a hardness above 300 Brinell is required. The small amount of distortion, as in the case of steel, is one of the advantages of this method. A 2-in. section may be successfully treated, but size is not necessarily a limitation where surface wear resistance is desired.

Tests on Cams

In recognition of the facts that austenite is plastic and also breaks down very rapidly from cold work, the possibilities of the structure for wear-resistant surfaces were considered. An accelerated service test was conducted to ascertain the comparative wearing characteristics of cam metal as-cast, hardened and tempered cam metal, and the austenitic cam metal.

Three cams of the same analysis from the same melt were set up in the machine where they would ordinarily be used, and the machine was speeded up to double its normal speed. The first cam, as-cast, had a Brinell of 228 and broke down in 30 mins.; the second cam, quenched in oil and tempered to a Brinell of 360, broke down in 17 hrs., and the third cam, hot-quenched to a Brinell of 360, was run 105 hrs. with very little damage at the end of the run.

It is felt that the wear-resistant properties may be attributed to the combination of the austenite and Bainite. Where austenite is produced in conjunction with martensite and then the austenite is broken down into martensite by cold work, the wearing qualities are not so apparent.

The mechanism of inducing wear-resistance is furthered by the actual use of the part. As work is done on the surface of the cam or whatever the part may be, the austenite breaks down on the surface, resulting in a combination of a martensite and Bainite layer, cushioned underneath by the core of unworked austenite and Bainite. In addition, if there is wear over a period of time as the surface is removed, the austenite breaks down further into the section and hence lengthens the wearing life of the part.

A more quantitative indication of the wearing properties of the hot-quenched iron may be obtained from the results of surface endurance tests carried out by Prof. Buckingham of Massachusetts Institute of Technology. In these tests, samples in the form of rolls were mated with a hardened alloy steel roll under various loads and a stress cycle curve developed. The following values of safe loads on the basis of 10,000,000 cycles with no slip, indicate more quantitatively the same results as the practical cam service test:—

Safe applied load. Lbs.	Condition of iron.	Brinell hardness.
1,000	As cast	230
2,000	Oil-quenched	300
3,000	Hot-quenched	300
With 9 per cent. slip		
1,200	As cast	190
2,000	Hot-quenched	280

There are many practical applications of this method—cams, gears, wiping plates, clutch discs, cylinder liners, piston rings, planer and lathe ways, bearings, etc. Most of the above-mentioned parts treated by this method are showing satisfactory service in industry.

There is still plenty of research work to be done with cast iron, and as this work progresses it will be found that cast iron is not just pig-iron melted in a cupola and poured into a mould, but a very fascinating useful material, of which the real properties have lain dormant because of insufficient interest and work.

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Non-Ferrous Applications of Top-Pouring Methods

(*Concluded from previous page.*)

quate to keep the down-gates filled. These down-gates for large castings have been made by cutting holes of the desired size through a flat stock core, which serves also as a bottom for the extremities of the box.

The second factor of importance in the use of top-pouring is the necessary revision of pouring temperatures. Experience would seem to indicate that the alloys to be cast should be divided into two classes: (1) The normal alloys, which are those having the following properties:—(*a*) little tendency to form dross, (*b*) great increase in crystal size with moderate increase in freezing time, and (*c*) inter-crystalline rather than bulk shrinkage; (2) the so-called high-shrinkage alloys that are characterised by the properties of (*a*) the formation of large amounts of dross, (*b*) the presence of iron or of some other alloy that serves to control the crystal size, and (*c*) bulk or inter-crystalline shrinkage.

Pouring Group 1 Alloys

The first group of alloys may be represented by 90:10, 80:10:10, or 88:8:4. It has been the author's experience that such alloys must be poured at lower temperatures when top-gating is used than when they are cast by conventional methods. This decrease in temperature is made necessary by the fact that the metal entering the mould is at a higher temperature than when it is compelled to supply heat to dry and warm the lengthy passage through the mould that constitutes the conventional gate. As an example, a temperature drop was found between the gate and the riser of a 3,500-lb. ring, cast by the conventional system, of 100 deg. C., while the drop in the case of a top-poured casting is less than the error of the pyrometer used.

The most apparent effect of these higher metal temperatures is the greatly increased crystal size, together with an accentuation of the inter-crystalline shrinkage. This is presumably due to the smaller freezing range caused by the greater homogeneity of the slowly frozen metal.

Pouring Group 2 Alloys

The second group of metals is typified by the aluminium bronzes and the manganese bronzes. No great amount of these metals has been poured by other than conventional methods, but such work as has been done indicates that pouring temperatures for top-gating must be as high or higher than when the normal bottom gates are used. The first and most important reason is that if too low temperatures are used, dross entrapping results. Experience seems to show that simple castings should remain liquid for at least a minute per foot of vertical height if the dross formed on pouring is to float out to give good physical properties. Where freezing is more rapid, the condition shown at the left in Fig. 1 may result.

It is fortunate that the iron content of these alloys is such that the desirably small crystal size is maintained in spite of the somewhat higher temperatures used. In addition, the non-dendritic type of crystal, found in these alloys, does not produce the same sort of shrinkage as is found in the first class of alloys and, as a result, feeding is ample.

Conclusion

It has been attempted, in the development of this Paper, to show that the use of top or riser gating is a very potent foundry tool that may be applied to many types of castings and to many different metals.

The author believes that the logical use of this type of pouring will solve some foundry problems and, in many cases, will allow the production of sound castings at less cost. The author has given his experiences in the development of a technique, and while he knows that better methods will be evolved, he hopes that these methods will offer a starting point for application that has not already been made.

Glass Technology as Applied to the Study of Vitreous Enamels

JOINT DISCUSSION OF MR. R. J. SLAWSON'S PAPER

In our last two Vitreous Enamelling Sections (July 4 and August 1) we printed the Paper on "Glass Technology as Applied to the Study of Vitreous Enamels," which MR. R. J. SLAWSON, M.Sc.Tech., presented at a joint meeting of the Southern Section of the Institute of Vitreous Enamellers and the Society of Glass Technologists. A report of the ensuing discussion is given below.

DISCUSSION

The CHAIRMAN (Mr. G. H. Abbott) said it had been a revelation to him, as an enameller, to hear for the first time that one could talk of enamel in terms of atoms. He added that Mr. Slawson was a member of the Sub-Committee on Chemical Resistance in the Institute of Vitreous Enamellers.

Correlating Properties of Steel and Glass

MR. A. MCLEOD (hon. secretary, Southern Section, I.V.E.), referring to the author's call for closer co-operation between the glass and enamelling industries, said he felt that advantage would be derived equally from the co-operation of those two industries with the steel industry. The metallurgist and the glass and enamel technologists came together in the production of enamelled ware.

Expressing particular interest in the references made to the physical properties of glass and enamel, and the influence of the rate of heating on glass and enamel, he said he knew something of the variations which could occur in the structure of metal as the result of variations in the rate of heating, and he suggested that independent research correlating the firing temperatures of the metal and the enamel would have great value.

Having regard to the mechanical strength of glass and the fact that many *ersatz* articles such as stockings, etc., were made with glass, he asked whether there was any likelihood of vitreous-enamel surfaces being made sufficiently strong to withstand simple deformation with the metal to which it was attached, as, for example, in a press.

High-Phosphorus Steel Suggested

MR. R. J. SLAWSON, replying to the question concerning the firing temperatures of metal and enamel, drew Mr. McLeod's attention to a Paper published in the Journal of the American Ceramic Society for April, 1940, dealing with the use of high-phosphorus steels for enamelling. He believed that in those steels the temperature of transformation was higher than in normal steel or iron. It was suggested in the Paper referred to that the use of high-phosphorus metal would allow the enameller to use harder enamels and, therefore, to use a firing temperature which would be much higher than those at present in use, but still below the transformation point of the metal.

He doubted that vitreous enamel coatings on metal would be made sufficiently strong to withstand deformation by pressing. The enamel coatings applied to metal were of much greater thickness than the threads used for spun and woven glass, and he did not think it was very likely that the thickness of enamel coatings on metal would ever be reduced sufficiently to enable them to withstand deformation by pressing.

Chemically Resistant Glasses

MR. W. E. BENTON, discussing the chemically resistant glasses, urged that the distinction between those glasses and other glasses was not just one of utility, but was a fundamental distinction, because a resistant glass was surely of more chemically stable composition than other glasses. In asking what produced that stability, he said the old glassmakers had claimed that one could not make a stable glass with one basic oxide and one acid radical; one must have a soft oxide and a hard oxide. In the various glasses there was a hard oxide which gave a silicate insoluble in water, and a soft oxide giving a silicate soluble in water.

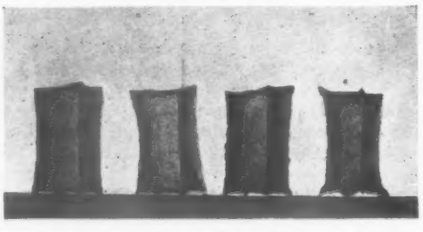

FIG. A.—EFFECT OF MIXTURE OF HYDROFLUORIC AND SULPHURIC ACIDS ON RECTANGULAR GLASS PRISMS.

He asked Mr. Slawson to indicate the importance of the presence of hard oxides, and in particular the function of alumina. In a molecular formula enumerated by one worker, the silica and boric acid were on one side and all the basic oxide on the other, the alumina being placed in the middle as though it had a very special function. Mr. Benton could not imagine that alumina was entirely distinct from oxide in the composition of glass.

As the glass set, there must be certain strength in the outermost surface, and he asked whether there was orientation of the molecules. The matter was a little clearer on the random network theory, that there could not be definite molecules of enamel turning round so that one portion faced the top. What evidence was there of the dependence of surface tension on composition, and particularly on the presence of oxides which (as was known) tended to improve the chemical resistance?

Discussing the colouring of glass, Mr. Benton said that surely crystals could only become coloured by admixture; one could not dye a crystal, but one could dye a glass. If a glass contained 0.1 per cent. of cobalt oxide, that oxide would be perfectly diffused, in the same way as sugar when dissolved in water. A colour was just something which gave a selective reflection or transmission of a wavelength in the visible spectrum; the visible spectrum was not a very great part of the whole spectrum, but it was very important to enamellers.

Complexity and Chemically Resistant Enamels

MR. SLAWSON said that any attempt to answer Mr. Benton's questions by any means completely would involve a very large number of references, and at the time of speaking he could not give those references. However, in regard to the difference between glasses which were more or less chemically resistant and those which were not, he said that, in general, the larger the number of constituents the more stable was the glass. Alumina seemed to present a special case. Of the main constituents of the glass, alumina was the only amphoteric oxide, and that was probably one reason why it was placed by itself in the molecular formula. Generally the soft oxides were the alkalis, and the hard oxides were the acids. It was not necessary, of course, for a glass to be complex in order to be chemically resistant; fused silica itself was an outstanding example, for it was remarkably chemically resistant. It had been stated that, for use in analysis, for instance, it was stable to lime up to a temperature of 1,000 deg. C.; above that temperature it tended to crystallise.

Certain non-resistant glasses were used for special purposes, as in making lenses, where the glass was protected by the rest of the lens mounting from any chemical attack; certain glasses with unusual optical properties were required for the preparation of anastigmatic lenses, and such a glass could be used where the rest of the lens protected that particular glass. Also, some of the earlier ultra-violet transmitting glasses, although admirable for the transmission of ultra-violet light, were almost soluble in water; obviously, they were not used very much.

Solution of Glass Cubes

A great deal of work had been done on the subject of surface tension, particularly with reference to the constitution of glass; but he had not dealt with it in his Paper, for it was a subject which concerned only the glass technologist. Inasmuch as Mr. Benton had raised the question of differences at the surface, Mr. Slawson mentioned a peculiar effect he had noticed in a glass surface and which indicated that there was some considerable variation of properties actually at the surface. If one stewed a glass cube for some time in a mixture of hydrofluoric acid and sulphuric acid, then removed the cube from the acids, it was found to be covered with a layer of silica (which could be washed off) and one noted that all the edges had become sharpened and the faces concave (Fig. A); the more faces that met at the point in question the more resistant was the glass to the attack of the acids. He had never heard the subject dealt with in detail and he could not offer an explanation; but he had seen the effect and repeated it on numerous occasions.

Source of Colour

He could think of several crystals which were stained naturally, as, for instance, the famous blue-john; and the source of their colour was not known completely. In felspar the pink colour was largely organic; it could be removed by heating. He was not sure whether crystals

could be coloured satisfactorily by artificial means, but he imagined that it must be possible, judging by some of the artificial gems that were produced. The function of colouring oxides in glass seemed to be very much that of solution, or in many cases the formation of colloids; for instance, rubies had been shown to be colloidal in character, and he supposed that, if microscopes could be made sufficiently powerful they would reveal almost a molecular dispersion of the colouring matter.

Expansion of Glasses and Enamels

DR. J. H. PARTRIDGE commented on the difficulty of calculating expansion, and said that expansion could be determined only by measurement; he wished that enamellers would measure it, because thereby they might be able to throw some light on several of their problems. He spoke feelingly on the matter because on one occasion he had asked some reputable people to supply an enamel having an expansion coefficient of about 5^{-6}, and which they had said they could supply, but in fact the material supplied had had an expansion coefficient of about 10^{-6}, and it was quite useless for the purpose for which he had intended to use it. Emphasising the importance of expansion characteristics, he said that in the glass industry the expansion of the products was measured very regularly, and in some cases was exceedingly sensitive to changes in temperature and composition.

Enamellers might not be aware that glass was melted in very large quantities, in tanks holding as much as 500 tons in some cases; 100-ton tanks were quite common. The melting process was continuous, the materials being put in at one end and the glass taken out at the other, at a rate of perhaps from 20 to 25 tons per day from a 100-ton tank. Increase of temperature would affect the expansion characteristic very remarkably, and if, as in the case of glass for the electrical industry, the expansion must be maintained constant, changes must be made in the batch composition to counteract rises or falls in temperature. In order to maintain the expansion constant it was necessary to measure the expansion at least every two days; at his works it was measured frequently every day, sometimes as often as four times per day.

Enamellers should take steps to measure the expansion of their compositions, especially when those compositions contained large quantities of volatile oxides; if they did so they would obtain some very illuminating results.

Fish-Scaling

Discussing fish-scaling, cracking, and so on, he said it seemed to him that so long as enamels contained crystals, cracks would occur, because the difference in expansion as between enamel and a crystal was very great and, if one examined it, one would find that the enamel was very highly strained around the crystal. It was so in a glass. In some cases it had been found to be almost impossible to draw a reasonable rod from an enamel in order to measure expansion. If one could not draw a rod from a glass, one would say that it was a "rotten" glass. Glass was very smooth-working, whereas enamel was not, as a rule; and at his works, when certain jobs had had to be done on enamels, they had had to make the enamels themselves in order to ensure that they were smooth-working. Those enamels were for electrical work, and they had to withstand certain electrical effects.

Metal to Glass Interface Strains

As to the "fit" of enamel to steel, and a statement by Mr. Slawson that the enamel was not annealed, Dr. Partridge was of opinion that where the enamel was used to produce decorative effects it was annealed, having regard to the fact that it was applied in such very thin films.

Disagreeing with Mr. Slawson's explanation of expansion curves, Dr. Partridge recalled the work of Hull and Burberry, and said that in glass-to-metal joints it was found that the strain between metal and glass was almost entirely dependent upon the position at which the curves crossed each other; a strain could be prophesied from a knowledge of those curves by a person having some experience of measuring strains. In general, he supposed, enamel was successful because the film must be in compression. On the other hand, some recent American work had shown that the expansion of the enamel was very different from what was generally believed to be the case at the metal/enamel interface, due to the solution of iron oxide. Therefore, he urged the study of the effect of the solution of iron oxide on such properties. In laboratory experiments on the problem it was necessary, in order to obtain results, to work at much higher expansions than were usual in ordinary enamels.

Nature of Enamel Coatings

MR. MARDEN, discussing the enamelling process, said he understood that a frit was made, which presumably was melted as a glass; then there were added to the frit various loading materials, maybe different colouring oxides or presumably alumina or felspar, and the mixture was spread as a slip on the metal and was then fired. He asked whether any sort of homogeneous coating was really produced on the surface of the metal in that way, because it seemed to him that it would consist of a mixture of the enamel with various lumps or crystals of the loading materials dispersed about the surface, perhaps in quite an irregular form. From the point of view of the glassmaker, that process would appear to court disaster. Yet it seemed to be satisfactory in the enamelling industry.

Calculating Expansions

MR. SLAWSON replied that most certainly the enamel was not homogeneous, and in many cases the heterogeneity extended so far that a large number of gas bubbles were present; some methods of securing opacity involved the production of large numbers of gas bubbles in the enamel. Commenting on the remarks of Dr. Partridge, he agreed entirely that enamellers should measure the expansion of their enamel rather than try to calculate it. Many of them did neither, however, and it was better to try to calculate it than to do nothing at all about it.

DR. PARTRIDGE said that one could be led astray in trying to calculate expansion. He added that, when working on the same batch, one could get a different expansion figure every day unless very great care were exercised.

MR. SLAWSON agreed that that was quite likely. He believed that in America, at any rate, regular determinations of thermal expansion were made; but in this country, so far as he was aware, enamellers did not make regular determinations.

With regard to annealing, he said he had meant that there were no intentional annealings of the surfaces. As to strains, he admitted that in general the point at which the expansion curves crossed was the main factor; but by controlling the rate of heating it might be possible to alter the resultant strain.

Enamel Adherence

The effect of iron oxide, of course, had entered into a number of the various theories regarding the adherence of the ground coat, which almost invariably contained cobalt, nickel, manganese or other oxides of that type; and it seemed that in general the enamel was enabled to adhere to the iron by the fact that it did react with the iron. If one prevented it reacting, the adhesion was lost.

Homogeneous Enamels

The CHAIRMAN recalled having carried out some experiments a few years ago with a view to making the enamel homogeneous, first of all by oxidising the metal and then firing in nitrogen. He had ensured that sufficient oxide was present to form a layer. That particular enamel was entirely free from bubbles; in that respect it was more homogeneous than an ordinary enamel, and when tested in a bending machine it was found to have extraordinary adherence. There was a greater concentration of iron oxide near the surface. One had a finishing material having a certain expansion, and one had to approach the expansion of the metal by intermediate layers; the iron oxide, by solution, conveniently raised the expansion of the finishing material enormously in order to make that approach possible. If in fact the enamel surface could be of exactly the same expansion as the metal, so that it was not under compression, he asked, would not the adherence be much better and would not the tendency to chip be reduced?

Strength of Glass in Compression

MR. SLAWSON replied that that would not follow entirely, because a rather peculiar mechanical property of glass was that it was very much stronger in compression than in tension; therefore, the enamel layer was less likely to be damaged if it were already in compression. Breakage usually occurred due to the formation of tension at the surface; if some compression were present in the first place, the strain would have to be very much greater in order to reach the breaking tensile stress than would be the case if there were no compression present originally.

The CHAIRMAN asked whether the lack of homogeneity contributed to that compression.

MR. SLAWSON said the fact that the layer was not homogeneous did not necessarily contribute to the compression. The fact that it was not homogeneous certainly contributed to the formation of areas of strain which were certainly likely to reduce the strength. He did not think the mere fact of the whole thing being in compression would reduce the strength of it; but if there were small areas in tension they would most certainly reduce the strength.

The CHAIRMAN asked why that state of affairs did not arise as the result of introducing all kinds of materials which would not go into solution in the melt. Would not theory point against the practice of introducing such materials? It was common practice in enamelling to introduce at the mill as much as from 5 to 10 per cent. of quartz or felspar, which, with a brief firing of 3, 4 or 5 minutes, could not possibly go into solution in the frit.

MR. SLAWSON said he personally would have thought that the introduction of such materials would be inclined to cause trouble; but he knew that it did not, and he could only assume that that was because the materials were so finely ground that the area of strain was insufficient to cause general failure.

Annealing is Present in Enamelling

MR. FRY, recalling Mr. Slawson's point that the annealing of an enamel might adversely affect the properties of that enamel, asked how he would explain the result obtained from the use of the continuous furnace, if not by annealing of the finished article.

MR. SLAWSON replied that possibly his remark with regard to annealing had been taken a little too seriously. He admitted that extremely slow cooling would be needed to increase the strain in so thin a layer; probably it would not show in the enamel itself and could be detected only by taking strain measurements. He could not imagine that it would give rise to sufficient strain to cause trouble.

Zirconia as Chemical Resistance Improver

The CHAIRMAN said the suggestion to use pure potash ground coats should be of considerable

interest to the suppliers of raw materials! A considerable amount of work had been done on the effect of smelter gases on the enamel during preparation, by Prof. Andrews and by others in America; Prof. Andrews had published a Paper on the subject.

The references to zirconia were particularly interesting, and from Table VII it would appear that zirconia was just the material that enamellers wanted; it was at the top of the table for all purposes. Miss Dimbleby, in a lecture, when referring to the chemical resistance of enamels, had said that zirconia was the material which enamellers would expect to be most promising, judging by its behaviour in glass. The chairman added, however, that in his experience it was not the most promising material; the enameller always turned to titania when he was looking for something to increase chemical resistance. He asked if Mr. Slawson could refer to any particular Paper or to any particular experience showing that zirconia had contributed to the chemical resistance of enamels.

Titania Favoured by Enamellers

MR. SLAWSON said zirconia did not appear to be so remarkably chemically resistant in enamels as in glasses, and he agreed with the chairman that titania appeared to be the material for enamellers to use from that point of view. In the experiments on glass, however, where the sodium oxide in the sodium-oxide-silica glass was replaced by zirconia and other materials, it was found in every case that zirconia gave the highest chemical resistance. That did not seem to apply in enamels; whether or not that was due to the large amount of boric oxide present in enamels he did not know.

The CHAIRMAN asked whether titania behaved in glass as it did in enamels.

MR. SLAWSON replied that it conferred fairly high chemical resistance in glass, but not so high as silica, for instance.

Zirconia as an Opacifier

DR. G. T. O. MARTIN (Research Officer, Institute of Vitreous Enamellers) said it was a fact that enamellers did not use zirconia in the way that glass technologists used it; he did not think the enamellers would waste their money on applying it to a clear enamel. It was chiefly an opacifier rather than part of the basic composition.

The CHAIRMAN pointed out that materials of that type increased the general mechanical properties of the enamel.

DR. MARTIN agreed and said that he had that in mind; but perhaps it had never occurred to enamellers that zirconia might be useful in increasing the chemical resistance of the enamels.

The CHAIRMAN said he believed enamellers had tried it fairly extensively.

DR. MARTIN commented that he had never seen any printed reference to its use for increasing the chemical resistance of enamels; it was usually mentioned only as an opacifier. The problem of making mill additions, he continued, appeared to confound the glass technologists, and they seemed to think that it was a scatter-brained thing to do. It occurred to him that materials which were added as opacifiers could affect many different properties. For instance, he had seen references to the chemical resistance of enamels being increased due to the opacifiers used; other people, on the other hand, had claimed that opacifiers must decrease the chemical resistance of the enamels. He asked for Mr. Slawson's views on that matter.

Dampness and Strength of Glass

Referring to the strength test, and the point that the strength of the glass as determined by the test depended on the size of test piece used (*e.g.*, a glass particle would be much stronger than a rod), he said that moisture also affected the strength, as shown by results recently published by the Bureau of Standards in U.S.A. concerning the effect of moisture on the strength of enamel; presumably the same considerations would also apply to glass. The breaking strength of a fibre of enamel was much greater in the absence than in the presence of moisture; and when coated with wax it was stronger than when exposed to the air. The experimenters had proved that even when the enamel was fused on the metal it was stronger in the absence than in the presence of moisture. He asked whether glass technologists were ever concerned with glass in such thin layers or films or threads as would introduce that factor.

Again, the fact that enamel on metal was not homogeneous affected the interpretation of any impact or other test. In the case of a glass bottle, which consisted of fairly solid glass, one might presume that an abrasion test which involved light pressure or scratching would give the same result as one involving heavy pressure or scratching; two kinds of glass, subjected to abrasion tests, might be placed in the same order. In the case of enamel, however, light scratching might not cause damage, but heavy scratching might break through the bubble structure. Therefore, great care must be used in interpreting hardness tests on enamel when fused on metal.

He wondered whether substances which rendered vitreous enamels heterogeneous (such as opacifiers) could affect properties such as the viscosity of the molten enamels. In that connection he recalled having been told of a formula which enabled a really super-opaque enamel to be made, and which depended to a large extent for its opacity on the presence of a fair amount of antimony. The enameller who had told him about it had melted the mixture in the furnace, but had found that it was so viscous that he could not pour it out. Dr. Martin asked if Mr. Slawson could give information as to how opacifiers and other ingredients melted into the enamel could affect viscosity. Would antimony oxide be homogeneous in the melt or would there be a solid suspension, and how would it influence viscosity?

Dampness and Fish-Scaling

MR. SLAWSON replied that he personally had not made experiments on the effects of mill additions on chemical durability; but he had seen much published work which was to a large extent contradictory, so that he preferred to say nothing on the matter.

He had already mentioned that fish-scaling, for instance, was worse in a damp than in a dry atmosphere; and the fact that glass was weaker in the presence than in the absence of water had been well known for quite a long time. Various explanations had been offered; one of them he considered to be very ingenious, and he did not know that he quite agreed with it. It was that minute faults formed in the glass acted as capillaries and absorbed moisture, and that the pressure of the moisture caused the faults to increase. That seemed to be rather far-fetched, but it might be true. Possibly fish-scaling was merely the slight weathering or roughening effect on the surface.

Antimony and Viscosity

As to the viscosity of the actual melt, he had not seen published data showing whether or not antimony dissolved in the molten frit and crystallised out afterwards, or whether it was insoluble in the frit when molten. He had been rather interested in the matter, and as the result of watching the pouring of antimony frits he was inclined to think that the antimony was, at any rate very largely, insoluble. He imagined that any insoluble material was likely to increase the viscosity, though he would hardly have thought that the amounts of antimony added for the purpose of opacity were likely to increase the viscosity so much as would matter. The majority of enamel frits were not particularly difficult to pour, and he would not have thought they would have reached the stage at which they would not pour.

DR. MARTIN commented that the formula he had mentioned was quite out of the ordinary.

MR. SLAWSON, referring to surface hardness, said that the problem of the depth of scratch certainly did apply in the case of enamel surfaces, and that was one of the reasons given for the use of the extremely finely milled enamels which some Americans were using. Some of them had gone so far as to mill the enamels in a colloid mill, and by so doing they had found a definite increase in the surface hardness, entirely due, apparently, to the reduction in the size of the gas bubbles present.

Ruby-Coloured Glass

MR. W. E. CHARLES, dealing with a statement by Mr. Slawson, in connection with the manufacture of ruby glasses, that if the selenium were added to a cold pot, the coloration was lost, due to the selenium volatilising and not being encased in the fused glass, asked whether that difficulty could be overcome by using a source of selenium such as sodium selenide.

MR. SLAWSON said he believed it could.

MR. CHARLES, commenting on Mr. Slawson's remark that, whereas ordinary enamels were just melted, glass remained molten for a considerable period, said he did not think there was any golden rule in the matter; quite a number of enamels were melted to such an extent that, he was convinced, if they were pressed into bottles, they would make some of the cheap bottles look rather poor.

MR. SLAWSON remarked that there was probably a basis for an argument there, in view of Dr. Partridge's remarks on the workability of enamels.

Interfacial Bonds

MR. A. E. BOULTON, discussing the reliability of the bond between metal and enamel, asked whether it depended entirely on the flow of the oxide into the metal, and what difference of expansion could be allowed, as between metal and enamel.

MR. SLAWSON replied that the difference that one could allow between the expansion of the metal base and the enamel varied very much, of course, with the thickness of the metal base. After all, in the case of the old enamels—he was thinking particularly of the old copper enamels—where the metal bases were extremely thin, one could put on almost what enamel one liked. The finished product was a piece of enamelware with a very thin piece of metal in the middle of it. Nowadays, industry was concerned with greater thicknesses of metal. He did not know whether or not any limit had ever been found for the difference in expansions that could be allowed, but for enamelling sheet metal he would imagine that the difference that could be allowed was fairly wide. Naturally, the nearer the expansion of the enamel was to the expansion of the metal, the better; but the bond could stand quite a big strain without the enamel coming off, although he did not say that it would not distort.

An Experiment with Zirconia

MR. LAITHWAITE said that some time ago he had experimented with the use of zirconia in enamel, and he had found that it was not so good as titania from the point of view of imparting acid resistance to the enamel. Having been trained as a glass technologist, however, he had experimented further in an attempt to explain the difference between the results obtained by Turner and his own results. He had melted the enamel as he would melt glass,

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i.e., he had extended the melting time from an hour or two to several hours, and had then obtained an enamel which was very resistant to acids. He mentioned the matter because it explained the apparent anomalies between the results obtained with glass and with enamel. The result obtained might have been due to the zirconia dissolving; but he had not pursued the subject further. One interesting point which had emerged, however, was that the enamel was useless for ordinary production; the viscosity was much too high.

Enamels in Compression Sought

As to the expansion problem, whilst he agreed with Dr. Partridge that perhaps enamellers should pay more attention to it than in fact they did, he suggested that on the whole the conditions in commercial enamelling were such that interest in expansion there was not so acute as in the glass industry. In his experience the expansion of enamels was not necessarily a criterion of good adherence or bad adherence to the metal; some enamels, having the same expansion coefficient, gave very different results in production. On the other hand, a change in the expansion coefficient sometimes gave a beneficial result. That change of expansion coefficient was not necessarily in the direction of the expansion coefficient of the metal to which the enamel was to be applied; and he mentioned a case in which appearance had been improved by altering the expansion coefficient of the enamel in the direction away from that of the metal. By reducing the expansion coefficient of the enamel and thereby increasing the compressive stress in the material when cold, the results were improved. Therefore, he did not agree with the chairman's remark that, ideally, the enameller might wish the enamel to have the same expansion coefficient as the metal; on the contrary, he deliberately designed the enamel to be in a state of compression after fusing.

Effect of After-Contraction

He had no evidence as to the extent to which after-contraction might occur in enamel, but he had a certain amount of evidence which suggested that the impact strength or the adherence in the case of cast-iron enamelled goods improved on storing. If after-contraction did occur—the suggestion was new to him—it meant that the compressive stress in the vitreous layer was reduced, so that possibly it would withstand impact better. His observations had, however, not yet been confirmed.

As to the effect of after-contraction on fish-scaling, he said that if there were after-contraction in an enamel which was already in compression, that after-contraction would tend to minimise the trouble rather than aggravate it, because the strain in the enamel would be reduced rather than increased; therefore, the tendency to fish-scaling should also be reduced.

Fish-Scaling and After-Contraction

MR. SLAWSON agreed with Mr. Laithwaite that if the fish-scaling were due to a strain between the iron and the enamel, after-contraction would reduce the strain and presumably would reduce the fish-scaling. He did not think that would be the case if the strain were due to what one might almost call a foreign material in the enamel, which material suffered no after-contraction. For instance, if one imagined that a crystal of felspar were present and that there was after-contraction in the enamel around it, surely the tensile stresses around that crystal would be increased?

Vote of Thanks

MR. MURGATROYD (Chairman of the London Section of the Society of Glass Technology) proposed a hearty vote of thanks to Mr. Slawson, and Mr. Benton seconded. The vote of thanks was carried with acclamation.

Present Position of the Vitreous Enamelling Industry

By J. H. GRAY, Jun., A.I.Mech.E. (J. Gray & Sons, Limited)

Readers may be interested in the following notes compiled from a survey of the industry, undertaken after the country has been at war for some months. As was to be expected, a percentage of men holding executive positions have been called to, or have voluntarily joined, one of the three fighting services. Others, like the writer, have taken temporary appointments either with the Government or with an establishment where their knowledge would serve some useful purpose and assist in the one desire—complete victory. There are others, of course, who, whilst having a strong desire to change from civilian clothes to uniform, realise, or have been convinced, that their service to their country is best performed by remaining at their pre-war posts.

Apart from the facts mentioned above, there have been a vast number of the younger male operators who have been conscripted, and a number of older men have offered their services in one form or another. There has also been a desire on the part of female operators to join one of the many important women's organisations or services.

Naturally, at the outbreak of war, nobody could say for certain what the position was going to be in the raw material market. Would prices increase rapidly? Would materials be hard to obtain? Or would the industry come to a standstill for the duration? However, for the first month or so, generally speaking, the output of the industry remained unaffected. The public purchased small stocks of enamelled goods; the merchants improved their stocks; enamellers increased their frit stocks, and frit manufacturers maintained their stocks of raw materials.

Then came the general slackening, although it is felt many will agree with the view that the falling off in production was not so great as was at first expected. The production curve probably dropped to 50 per cent., then to 33⅓ per cent. of the pre-war figure, and in some cases even lower, and this condition of affairs has since been maintained fairly consistently. Of course, some shops have fared better than others, depending on the geographical position of their plant and the type of work on which they were engaged.

The calling of men to the Colours was undoubtedly to some extent a relief to both the operators and the managements, as it overcame the need for dispensing with labour due to reduced production. It is interesting also to note that in many cases men on leave have called at the plants where they worked before their call-up, and have taken great interest in the conditions existing, comparing them with the times when they were working full-time, and everyone was interested in acid-resisting and new finishes, and the like.

Manufacturing Changes

Some of the larger concerns, controlling more than one works, have found it economical to close down one plant completely and to carry out enamelling for two or more works in the one plant, even though they may be some miles apart. Others, in the interests of economy, have been able to meet their reduced production requirements on an economical basis by closing down sections of their equipment.

There are also a few companies which are utilising their enamelling muffles, semi-muffles, and furnace equipment to carry out the heat-treatment of metals for the trade. In a number of cases enamellers' sandblast plants are doing some useful work of national importance, whilst other equipment is being used for various processes such as metal spraying, etc. Perhaps it will not be surprising to hear that most companies with de-enamelling plants are making good use of them and they have proved to be an asset.

A few enamelling plants which are laid out to enable them to do so, are enamelling service water bottles, hospital equipment, cooking utensils, gas and electric cookers for canteens, and there is still a demand, although limited, for A.R.P. signs.

It is very difficult to foresee how the trade will be affected in the event of further intensification of the war. However, everybody in the trade seems optimistic and confident that things will continue "to tick over." One thing which is reasonably certain is that the industry as a whole can look forward to at least a period of high production after we have straightened things out in Europe and are able to forget aggression, and get back to Institute meetings, and to the very many interesting and friendly, if slightly "fused," discussions. Moreover, works visits will be events eagerly anticipated after this period of strain.

The writer is of the opinion that the equipment, such as furnaces and auxiliary equipment, sand-blast and pickling plants, etc., can be quickly and easily adapted for carrying out safely and economically, work for which they are suited, for aircraft, Admiralty or Army production, and thus relieve pressure being placed on equivalent plants in other industries.

Cast-Iron Piston-Ring Pots

(*Continued from page* 154.)

The mean external diameter (d) of the ring in the closed position shall be calculated from the measurement of the circumference taken by means of a calibrated tape or other equivalent method.

In order to remove a degree of permanent set from the ring and thus obtain uniform and strictly comparable values of En, the change of width of gap shall be measured on a second test, *viz.*, after the ring has once been closed, allowed to open and again closed.

Transverse Breaking Strength.—The following test shall be carried out to the satisfaction of the Inspector:—A test ring cut from the pot to an approximately square section or to a section approximating to that of the finished ring shall be split and pulled apart in a testing machine by a load applied at opposite ends of the diameter which is at right angles to that through the gap. It must withstand a stress of at least 24 tons per sq. in. before fracture, calculated by the use of the following formula:—

$$S = \frac{PD}{1{,}200\ bt^2}$$

where S = Stress in tons per sq. in.
D = External dia. of the unsplit ring in inches.
P = Load in lbs.
b = Width of ring in inches.
t = Radial thickness of ring in inches.

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GRADE		RECOMMENDED USES	REMARKS
ACTIVE FLUXES These are characterised by rapidity in working and ability to remove quite considerable films of oxide, rust and grease from the surfaces of the joint members.	**"Frysol" Tinning Salt**	"Frysol" Fluxes are rapid in action and suitable for all normal soldering on steels, copper alloys, tinplate, galvanised iron and all metals except aluminium. Powder flux which is made up as required by dissolving 2-4 lb. per gallon. Provides the most convenient way of storing flux.	Approved I.N.O. W.O. and A.I.D. for general soldering work. Like all active fluxes these fluxes leave a residue which may cause corrosion. After soldering the joint should therefore be wiped with a cloth or washed either in warm water or in a weak 1 per cent. hydrochloric acid.
	"Frysol" Soldering Fluid	Made from "Frysol" Tinning Salt and supplied in three strengths :— Black Band — strong for wrought iron, steel, etc. Green Band — medium strength for general soldering. Yellow Band — for general soldering such as brass, copper, etc. Suitable for all types of dipping work.	
	"Frysol" Paste Flux	Active flux in convenient form, especially suitable for bit soldering.	Surplus flux should be removed by wiping.
SAFETY OR PROTECTIVE FLUXES — NON-CORROSIVE These have little chemical activity and therefore can exert only a slight cleansing action. It is therefore necessary to start with a reasonably clean surface.	**"Alcho-re" Paste Flux**	Electrical and radio work and other soldering duties where freedom from acid action is essential. For copper, brass, tin, pewter, tinplate.	Approved A.I.D. The flux leaves a dry residue which is a non-conductor and also non-corrosive. If desired the residue can be removed by wiping with a cloth moistened with methylated spirits.
	"Alcho-re" Soldering Fluid		
	Fry's Oleic Acid No. 9	Liquid safety flux used extensively for War Office and Admiralty work on ammunition boxes, smoke floats, etc. For copper, brass, tinplate, iron and steel. Equally suitable for hand soldering and dipping work.	Flux residue is a non-conductor; it is removed by wiping.
SPECIAL FLUXES	**"Fryolene" Flux**	Quick action, non-acid paste flux, suitable for monel, nickel, chrome, as well as iron and non-ferrous alloys. Also supplied in liquid form for dipping work.	Flux residue harmless, but can be removed with warm water or warm cloth.
	Fry's Zinc Flux	Non-corrosive powder flux suitable for zinc, zinc alloys, galvanised iron.	Flux residue is non-corrosive. It can be removed by wiping.

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The Week's News in Brief

Trade Talk

THE PORCELAIN ENAMEL INSTITUTE is to hold its fifth annual forum at the University of Illinois, Urbana, Ill., from October 16 to 18.

THE Executive Council of the Iron and Steel Trades Confederation have decided to send a cheque for £5,000 to the Minister for Aircraft Production to buy a "Spitfire" fighter.

MR. R. B. SUMMERSON, chairman of Thomas Summerson & Sons, Limited, Albert Hill Foundry, Darlington, declared open last month a sports field and pavilion which the firm, which was founded in 1840, has presented to its employees to mark its centenary.

THE AMALGAMATED ENGINEERING UNION is asking for an increase of 3d. per hour on basic rates and the restoration of pre-1931 conditions. The Confederation of Engineering and Shipbuilding Industries claims a weekly increase of 10s. Negotiations opened last week.

THE National Arbitration Tribunal has given its award on the claim of workers in the Midland brassfoundry industry for an increase of pay. The increases asked for were 7s. per week for men; 3s. 6d. per week for youths. The men have been granted 4s. per week and the youths 2s. per week, both as from August 24.

ACCORDING to reports from Phoenix, Arizona, the largest nickel deposits yet found in the United States have been discovered in north-western Arizona, near Littlefield. The deposit is stated to stretch 12 miles and to vary in width from 600 to 1,400 ft. Surface samples show a nickel content of 0.68 per cent. with a small proportion of platinum, which might rank as a by-product.

SIEMENS-SCHUCKERT (GREAT BRITAIN), LIMITED, of Great West Road, Brentford, Middlesex, have entered into an agreement with Mr. Victor Stobie, of Dunston House, Harrogate, to manufacture under an exclusive licence high-frequency furnaces to his Patents. The company already manufactures a large range of furnaces, including arc furnaces, heat-treatment furnaces for ferrous and non-ferrous alloys, salt baths, etc.

THE production of steel ingots and castings in Canada during June amounted to 166,213 tons, compared with 174,417 tons in the preceding month and 107,902 tons in June of last year. For the first half of this year the total output was 958,246 tons, against 580,141 tons during the six-month period ending June 30, 1939. Production of pig-iron in Canada in June was 88,656 long tons, compared with 93,254 tons in the previous month and 52,805 tons in June, 1939. During the first half of 1939 production totalled 296,521 tons.

THE SECOND of the Air Raid Precautions Training Bulletins which the Ministry of Home Security is issuing, is now available. These bulletins are issued for the benefit of instructors, and more particularly those in commercial and industrial establishments who have not the same opportunities for keeping in touch with the latest developments in A.R.P. matters as have local authorities' staffs. Instructors are recommended to place a standing order with the Stationery Office for the further Bulletins which will be issued from time to time. The price is 6d. (8d. post free).

WITH the object of reducing the number of types of certain categories of land and marine internal-combustion engines required by the Service Departments and making possible acceptance of the commercial specifications of approved firms, the Industrial Capacity Committee of the Production Council has appointed an inter-Departmental committee to ascertain the requirements by the Departments of the specified types of engines and to plan the distribution of orders with the intention, where possible, of standardising specifications and of reducing the number of types and sizes.

AMONG THE OLD GUNS which were recently dug up on Tower Hill for the Ministry of Supply's scrap campaign, a number were found to bear the mark of the Tudor rose with crown superimposed. For that reason they are believed to be relics of the Marlborough Wars and not, as previously supposed, either French of the Napoleonic period, or German cannon taken from wooden men-of-war. Because of their historic value, Mr. J. G. Mann, Master of Armouries at the Tower of London, has secured the co-operation of both the Ministry and the Office of Works to keep back 12 of the guns, and those in the best state of preservation will be selected for a collection. After the war Mr. Mann proposes to mount four of the collection on the Tower Wharf inside the Tower, and to distribute the others to such historic fortresses as Edinburgh and Stirling Castles. Before Queen Anne's death in 1714 ordnance bore the Tudor rose and crown. At the accession of George I all pieces were marked with the Royal cipher "G.R." Ordnance made during the 18th century is rare, because there was a nation-wide scrap campaign organised by Pitt to help in the defeat of Napoleon.

THE FINANCE BILL which has just become law empowers the Commissioners of Customs and Excise to prescribe the final date by which persons who are required by law to register for Purchase Tax purposes must do so. The Commissioners have made an Order (S.R. & O., 1940, No. 1552) requiring all persons now carrying on a registrable business to apply for registration before September 20. Manufacturers of Purchase Tax goods and wholesale dealers in such goods who have not yet received a copy of the Customs explanatory leaflet and the necessary form of application for registration should obtain one, without delay, from the local Officer of Customs and Excise or from the Custom House, London, E.C.3. Registration under the Purchase Tax is, of course, entirely distinct from the Board of Trade registration in connection with the Limitation of Supplies Orders, though the two schemes have certain features in common. The question has been asked why registration is necessary for Purchase Tax purposes. The first answer is that it is a legal obligation and heavy penalties are incurred by failing to do so before the above date. Further, a firm which is not registered is unable to buy Purchase Tax goods tax-free for its business. On the other hand a firm incurs no additional liability by registration since the obligation to pay tax on its sales of such goods to retailers exists under the law whether the firm is registered or not. Copies of the Order referred to above may be obtained from H.M. Stationery Office, or through any bookseller.

Obituary

MR. DAVID PEACHMENT, of Bury, who was for 23 years with the Vaughan Crane Company, Limited, Openshaw, Manchester, died on August 25, aged 45.

M. JULES LOUIS BRETON, director of the French national office of Industrial Scientific Research, has died at Clermont Ferrand. With Colonel Etienne, he was responsible for the development of the French tank.

PROF. C. F. JENKIN, F.R.S., who was elected the first Professor of Engineering Science at Oxford in 1908, a post he held until 1929, died on August 23. He carried out important researches on fatigue failure under vibration, both in metals and in building materials.

MR. HAROLD TATHAM EDDISON, a director of John Fowler & Company (Leeds), Limited, engineers, of Hunslet, has died at the age of 65. His father, the late Mr. Robert William Eddison, was a founder (with Mr. John Fowler) of Fowler & Company, and Mr. Eddison himself had been concerned with the works side of the company for many years.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

Die Casting Machine Tools, Limited, 122, Green Lanes, Palmers Green, London, N.13—Capital, £2,000. Directors: A. R. and D. I. Mills.

Harrow Machine Tool Company, Limited, 1a, Peel Road, Wealdstone, Middlesex—Capital, £1,000. Directors: C. R. Robertson and H. Diggle.

J. C. K. Engineers, Limited, 80, High Street, Bushey, Herts—Capital, £2,000. Manufacturers of forgings, castings, etc. Director: J. C. Knights.

Personal

DR. G. H. PIPER, B.Sc., was married recently to Miss M. M. Cryan, at St. Austin's, Grassendale.

CAPT. E. C. E. SMITH has been elected a director of John Brown & Company, Limited, of Clydebank.

MR. EDGAR P. BROWN has been appointed chairman of directors of the Caledon Shipbuilding & Engineering Company, Limited, in succession to his uncle, the late Mr. P. S. Brown.

IN OUR LAST ISSUE we announced that Pilot-Officer H. L. Newsom Davis had been reported as a prisoner of war. Actually he is posted as missing. We very sincerely regret that this mistake should have occurred.

MR. A. J. NEWMAN has been appointed by the Minister of Aircraft Production to be director of machine tools with responsibility for the supply of machine tools to the Ministry of Aircraft Production.

SIR ALEXANDER ROGER, chairman of British Insulated Cables, Limited, is chairman of a special mission which is on the way to India to discuss means of increasing India's production of munitions and other war stores.

MR. ARTHUR CROFT and his firm, Crofts (Engineers), Limited, of Thornbury, Bradford, have given outright the cost of an aeroplane as a lead in Bradford's communal campaign to raise funds for five Spitfires. Mr. Croft has recently given a motor ambulance for war casualties to Rawdon, the district in which he lives, £25,000 interest-free loan to the Exchequer, and a £25,000 contribution to War Bonds.

MR. THOMAS BUCHANAN, managing director of the Hammond Lane Foundry Company, Limited, Dublin, pioneers in Eire in the making of rainwater and soil goods, ranges and grates, who retired recently, had been with the company for 38 years. Under his management the company grew from a very small concern to the large organisation it is to-day with its five associated companies. Consequent upon the retirement of Mr. Thomas Buchanan, Mr. J. G. Bigger, assistant secretary, has been appointed commercial manager and Mr. J. F. Buchanan, son of Mr. Thomas Buchanan, has been appointed works manager. Mr. S. W. Aiken and Mr. G. J. Rowe, secretary, have been appointed as directors.

Wills

GREEN, F. J., of Birmingham, director of B.S.A. Tools, Limited	£6,028
GRAHAM, W. V., past chairman of the Association of Consulting Engineers	£8,529

Reports and Dividends

Quirk, Barton & Company, Limited—Interim dividend of 2½ per cent.

British Oxygen Company, Limited—Interim dividend on the ordinary stock of 7 per cent.

Bairds & Scottish Steel, Limited—Interim dividend of 3 per cent. on the ordinary shares.

Brightside Foundry & Engineering Company, Limited—Trading profit, £145,421; net profit, £82,601; brought in, £30,926; supplementary taxation to June 30, £22,000; dividend of 15 per cent. and a bonus of 10 per cent. on the ordinary shares; carried forward, £43,277.

Applications for Trade Marks

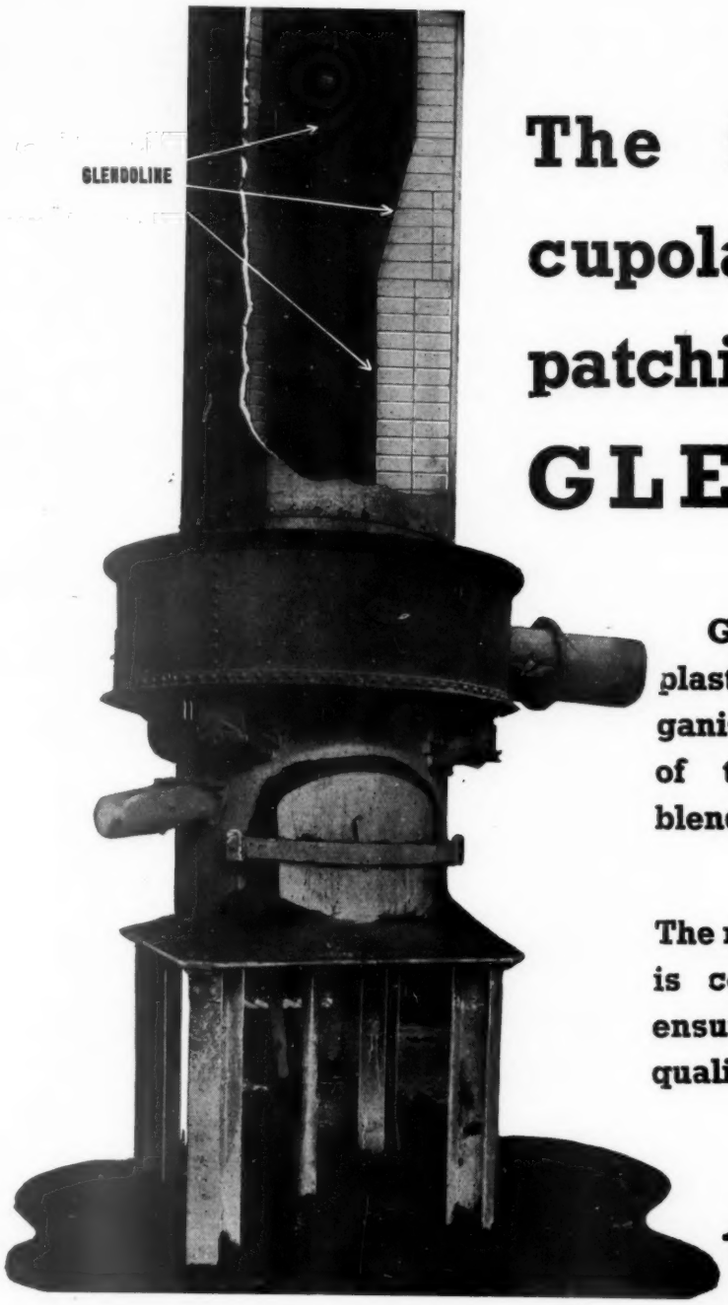
The following list of applications to register trade marks has been taken from the "Trade Marks Journal":—

"CERROBEND"—Alloys of common metals. CERRO DE PASCO COPPER CORPORATION, c/o Stevens, Langner, Parry & Rollinson, 5-9, Quality Court, Chancery Lane, London, W.C.2.

"BRUSH"—Electric motors, generators, converters, transformers, railway rolling stock, internal combustion engines, etc. BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, Loughborough.

Contract Open

Manchester, September 14—Supply and erection of three electrically-driven centrifugal pumps, with motor starters, pipes, valves, etc., for the Waterworks Committee. The Secretary, Waterworks Offices, Town Hall, Manchester, 2. (Fee £1 1s., returnable.)



The ideal cupola lining and patching material . . .

GLENDOLINE

Glendoline is a carefully prepared plastic refractory, comprising ganister stone from a selected bed of the famous Sheffield quality, blended with a special clay.

The mixing and grading of Glendoline is controlled to a definite formula, ensuring dependable and uniform quality.

★ EXTREMELY PLASTIC
★ HIGHLY REFRACTORY
★ GREAT MECHANICAL STRENGTH

★ This photograph of a cupola, shows a portion of the lining and the positions where Glendoline is recommended for lining and patching.

Please write for full information and descriptive leaflet to :—

GENERAL REFRACTORIES Ltd.

Telephone : *Sheffield* 31113 (6 *lines*). **GENEFAX HOUSE, SHEFFIELD** *Telegrams :* *"Genefax, Sheffield."*

Raw Material Markets

Foundrymen are taking a more active part in catering for the requirements of Government departments, but some makers of light castings continue to be poorly placed for new business and are unable to avoid short time. In many cases, however, manufacturers in this section have adapted their plant to deal with work of national importance. All sections of the heavy engineering industry are fully engaged and the demand for iron from these works is substantial. Only in exceptional cases are licences granted for the supply of iron to consumers other than those on Government contracts, but the needs of the latter are being met in full.

Pig-Iron

MIDDLESBROUGH—Foundry-iron consumers in this area are still unable to accumulate stocks, as the supply of iron from Midlands manufacturers, while adequate to meet urgent needs, is insufficient to facilitate the building up of reserves. Deliveries under licence are reaching users satisfactorily, but it is very difficult for users engaged on ordinary domestic work to acquire supplies. To all intents and purposes production of Cleveland foundry iron is still suspended and only makes a meagre contribution to the satisfaction of consumers' requirements. Heavy engineers are working to full capacity, but there is need for considerable improvement among light-castings makers, although the latter are slowly able to deal with work of national importance on a better scale.

After the needs of the local steelworks have been dealt with there is only a small surplus of East Coast hematite for distribution among other users. There is a very keen demand for any material which can be spared and the strictest control is exercised in making allotments. The production of additional blast furnaces would be readily snapped up and it is hoped that more furnaces will be devoted to the manufacture of hematite before long. Larger supplies of raw materials have recently enabled existing units of production to record improved outputs, but priority users continue to account for all the iron that becomes available. East Coast makers have also to cater for the needs of users in Sheffield and the Midlands and regular tonnages are being dispatched to these districts.

LANCASHIRE—A number of engineering concerns in this area has recently taken short holidays, but this has not been reflected in the demand for foundry iron, which remains on a heavy scale. With the exception of the light-castings trade, which continues to be only moderately employed, there is brisk activity among consuming works and large deliveries of Derbyshire and other brands of Midlands foundry iron are being called for. Business in Scottish foundry iron is on the quiet side. Hematite continues to be used in big tonnages, but supplies are having to be carefully distributed, as consumers on essential work are accounting for the bulk of the output.

MIDLANDS—The demand for high-phosphorus iron tends to expand still further; light-castings makers, being rather better employed owing to additional Government orders having been received, are taking up larger tonnages, while speciality engineers in many cases have adjusted their mixtures to include this type of iron, as deliveries of low-phosphorus iron and hematite are still unsatisfactory. It is possible that certain furnaces at present producing basic iron for the steelworks will be transferred to the production of foundry numbers. Consumption of iron by works engaged on orders placed by Government departments is such that there is little, if any, iron available for other consumers. As stated above, the position of light-castings makers has improved somewhat, but many works are still badly situated and until they are able to secure a greater proportion of work of national importance there are few prospects of their being able to show better returns. There may be more export business available soon, but this will be restricted owing to the comparatively small amount of iron which can be spared for the overseas markets. While quite a considerable quantity of ordinary domestic work could be taken on, this is naturally discouraged by the Control authorities.

SCOTLAND—Priority users of pig-iron are receiving adequate tonnages to enable them to maintain full-scale operations, but consumers are given no opportunity to build up stocks as a reserve to meet future requirements. Reports from the Falkirk district indicate that the position of the light-castings trade is about unchanged, and although the influx of a certain volume of Government work has improved their order-books, most makers would readily accept additional contracts. Pig-iron used in Scotland is being acquired from the English Midlands, trade with Cleveland producers having been suspended for a considerable time.

Coke

Foundry-coke consumers are generally in possession of considerable stocks and deliveries from the ovens continue to arrive satisfactorily. For delivery to buyers in the Birmingham and Black Country area, Durham best foundry coke is invoiced at 55s. 6d. per ton at stations. Users are adopting the wise policy of taking up all the supplies they can as a precaution against transport delays during the coming winter.

Steel

Proposals to raise railway rates and charges, which have been before the Charges (Railway Control) Consultative Committee, are being followed with keen interest by steel producers and consumers, as it is almost certain that if higher rates are introduced steel prices will have to be raised. On May 1 last railway charges were increased by 10 per cent. and steelmakers were compelled to raise their selling prices accordingly and it is unlikely that they themselves will be in a position to shoulder any new burden which may result from the current negotiations. Supplies of steel continue to be fully accounted for by the requirements of Government specifications and only a comparatively small tonnage can be released for other purposes. Improved deliveries of raw materials have enabled works to return increased outputs and indications are that this state will be maintained. Munitions and shipbuilding orders are involving the consumption of large tonnages of steel and only a small proportion of the heavy export inquiry can be entertained in the circumstances, but it is hoped that more attention will be paid to foreign orders later. Thus, the industry is faced with a stiff task in the future and it certainly cannot be said that demand has reached the peak. The needs of the works manufacturing products for the various Government departments are the chief concern of the producers, with every possible attention being devoted to foreign business; ordinary domestic orders are consequently relegated to the background and only the most urgent of these receive consideration by the Control authorities.

Scrap

Consumers of iron and steel scrap have recently been receiving very much improved deliveries, but the demand shows no signs of slackening and there is still a ready market for all that becomes available. Consumption is heavy, but it is now possible in some cases for users to accumulate small stocks and the fullest use is being made of the opportunity. Steelworks, foundries and general engineering concerns are keen to acquire reserves as a precaution against possible delays in deliveries at a later date and every effort is being made to facilitate this before the winter. In certain areas deliveries have become congested and dumps have been organised in the close proximity of consumers' works. While the anxiety with regard to supplies has abated, the scrap collection campaign is being pursued with undiminished vigour.

Metals

It is understood that the British Government has renewed the copper agreement with Rhodesian producers on the same terms as last year's agreement, when the Government contracted to purchase 265,000 short tons at a price of £43 10s. for blister and £48 10s. for electrolytic. The Government recently bought 100,000 short tons of Rhodesian copper over and above the tonnage stated in the first agreement, and for this contract a higher price was paid, presumably as some compensation for the incidence of 100 per cent. E.P.T., and should any further additional supplies be purchased some measure of price adjustment could doubtless be arranged if necessary. There was a clause in the original contract providing for allowance to be made for increased costs of labour, transport, etc., due to war conditions. This clause is again retained, but it is understood that no undue increase in costs from such causes has so far taken place.

Consumption of copper in the United Kingdom continues to expand, but supplies are adequate to meet all the requirements of the armaments programme and, in fact, to satisfy a moderate amount of export inquiry. The United States market is firm and, with the defence programme there gathering momentum, consumption is increasing, and must be expected to attain higher levels shortly. It is understood that the United States is now releasing copper bought by the Soviet Union, which was held up in the belief that some of the metal would have eventually become a contribution to the Nazi war effort if it had been despatched to Russia. Negotiations between the Soviet and Great Britain, however, are reported to have overcome difficulties in the way of shipment from America to Russia, and about 5,000 tons, it is said, have been shipped.

Shipments of American copper to the United Kingdom in July amounted to 18,854 tons, against 14,184 tons in the previous month. The July figure would appear to be rather high, but it should be realised that it includes purchases made by France which were taken over by the British authorities following the French armistice with the enemy. Also included in the July total are certain specifications of electrolytic copper ordered shortly before France withdrew from the conflict. Agreement was reached last year between British Empire copper producers and the Ministry of Supply under which Britain's copper requirements have been well met. The period of this agreement is due to expire at the end of this month, but renewal for a further twelve months is fully expected. It is likely that the price fixed in the new agreement will be raised, as costs of production have appreciated, and it was understood last year that when the question of renewal was considered any material changes in costs would be taken into account. The Empire is able fully to meet the United Kingdom's wartime requirements of copper, but there is need for shipments of American electrolytic copper, as refinery capacity is insufficient to cope with the whole of the supplies of concentrates.

The London tin market has been rather dull and uninteresting of late, and prices have tended to fall away. According to the August issue of the Statistical Bulletin of the International Tin Research and Development Council, world production of tin in July last is estimated at 18,800 tons, compared with a revised figure of 20,100 tons for June. This brings the total production for the first seven months of the year to 124,400 tons, against 77,600 tons in the corresponding period of 1939. United States deliveries totalled 57,934 tons in the first seven months of the year, showing an increase of 64 per cent., compared with 35,275 tons in the first seven months of 1939. World stocks of tin, including smelters' stocks and carry-over, increased by 7,619 tons during July, to 48,830 tons; stocks at the end of July, 1939, were 39,497 tons.

London Metal Exchange tin prices this week have been as follow:—

Cash—Thursday, £258 to £258 5s.; Friday, £257 10s. to £258; Monday, £257 5s. to £257 10s.; Tuesday, £255 10s. to £256; Wednesday, £254 15s. to £255.

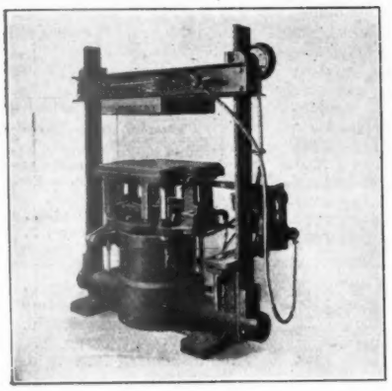
Three Months—Thursday, £258 10s. to £259; Friday, £258 10s. to £258 15s.; Monday, £258 5s. to £258 10s.; Tuesday, £256 15s. to £257; Wednesday, £256 10s. to £256 15s.

Supplies of both spelter and lead continue to be plentiful, and there is a surplus after the needs of the priority users have been satisfied. Thus it is possible to foster a certain amount of export trade so far as zinc and lead products are concerned.

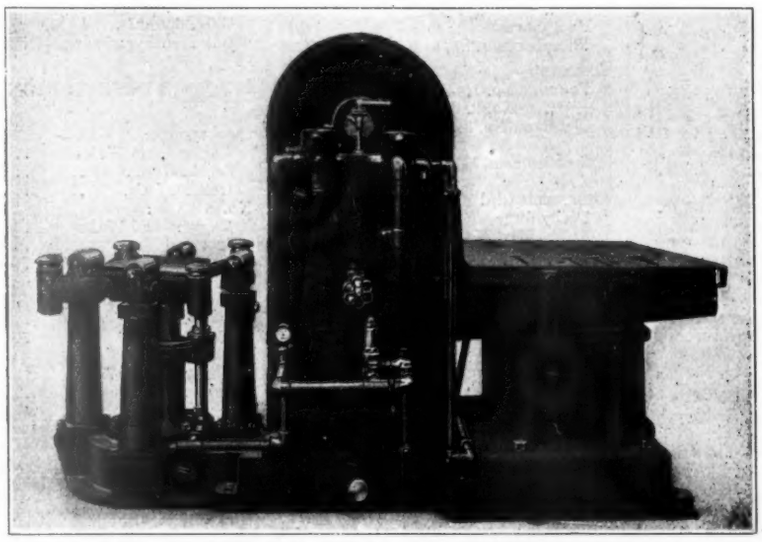
Detroit Foundry Capacity 785 tons Daily

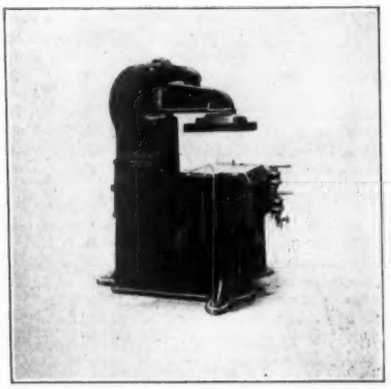
The Pontiac foundry at Detroit has recently been modernised, and the capacity is now 785 tons per day. Two new 27-ton per hour cupolas have been installed, and the slag produced from them is removed by a conveyor to quenching tanks for granulation. Additionally, new core-sand handling and drying plant capable of dealing with 50 tons per hour has been installed.

LATEST ENCLOSED SAND PROTECTED MOULDING MACHINES

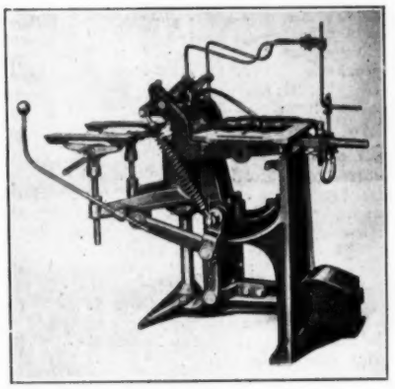


Power Squeezing "Split Pattern" Moulding Machine.





Latest Enclosed Sand Protected Jolt Squeeze Straight Lift Machine
Made in a range of sizes. Pattern draw—Air on oil.



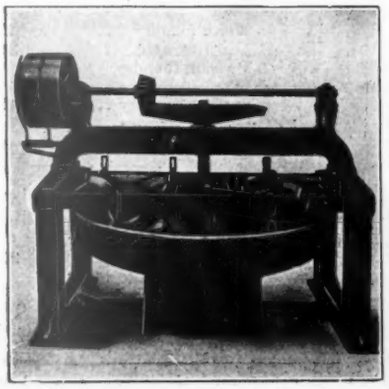
Hinge Type Hand or Power Jolt Ram Rollover Pattern Draw Machine.
For making Cores or Small Moulds.
Load Capacity on Table ... 200 lbs.
Pattern Draw 8". Boxes up to 24" × 16" × 12".

LATEST ENCLOSED SAND PROTECTED MODEL
"SHOCKLESS" JOLT RAM ROLLOVER PATTERN DRAW MACHINE

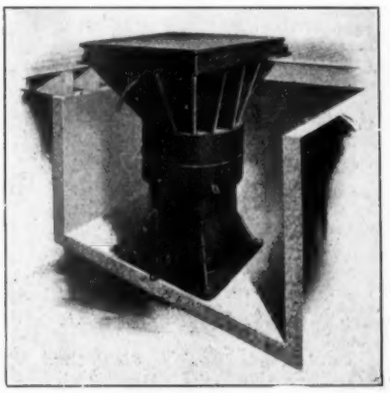
FEATURES:

MECHANICAL SIMPLICITY — SAND GUARDING
ACCURACY & STEADINESS OF DRAW (AIR ON OIL)
CLEANNESS OF DESIGN — SMOOTHNESS OF
ROLL-OVER (AIR ON OIL)

Scroll Roller Sand Treating Mill
(Gernelle-Danloy Patent).
These milling rollers or scrolls turn sand at the rate of 1,200 times per minute. Resultant mixing and milling effect unapproached by any other system.



SPECIAL TIME SAVING EQUIPMENT INCLUDES
INSTANTANEOUS POWER OPERATED CLAMPS
GRAVITY ROLLER DISCHARGE



"Shockless" Jolt Ram Moulding Machine.
Made in a range of sizes to take loads up to 35,000 lbs. at 80 lbs. air pressure.

MACNAB & CO., LTD.,
150, Holborn, London, E.C.1

RAW MATERIALS—PRICE LIST

Wednesday, September 4, 1940

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined ..	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent. ..	60	10	0
Black hot-rolled wire rods..	65	10	0

TIN

	£	s.	d.
Standard cash	254	15	0
Three months	256	10	0
Settlement	254	15	0
Official average Cash, Aug.	262	12	$4\frac{7}{11}$
Do. Three Months, Aug.	263	1	$1\frac{7}{11}$
Do. Settlement, Aug. ..	262	10	$8\frac{3}{11}$

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western" ..	26	10	0
Refined and electrolytic ..	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b. ..	30	0	0
Pipes, home	34	0	0
Do. export, f.o.b. ..	30	10	0
Tea lead (nom.)		—	

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises ..	28	7	6

ANTIMONY

English, 99%	90 0 0
Foreign Regulus, duty paid ..	90 0 0 to 93 0 0
Chinese, prompt shipment, c.i.f. ..	79 0 0 to 82 0 0

QUICKSILVER

Quicksilver, ex-w'hse London	54 10 0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 0d.
Finished bars, 18% tungsten	3s. 10d.
Finished bars, 22% tungsten	4s. 4d.

Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising ..	9d. to 1/3
Rolled—	
To 9 in. wide ..	1/3 to 1/9
To 12 in. wide ..	1/3½ to 1/9½
To 15 in. wide ..	1/3½ to 1/9½
To 18 in. wide ..	1/4 to 1/10
To 21 in. wide ..	1/4½ to 1/10½
To 25 in. wide ..	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
to 10g.	1/6½ to 2/1½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/5½ upwards.

Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

(all prices nominal)

	£	s.	d.
Ferro-silicon—			
25%	18	10	0
45/50%	21	10	0
75%	31	0	0
Ferro-vanadium—			
35/50%	15/6 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free ..	6/- lb. Mo.		
Ferro-titanium—			
20/25% carbon-free ..	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	—		
Max. 1% car.	—		
Max. 0.5% car. ..	—		
70% carbon-free ..	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot ..	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	0	0
76/80% packed	19	10	0
Metallic manganese—			
94/96% carbon-free ..	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths.. ..	3	16	6	to 3	19	0
Heavy machinery cast iron		4	6		6	
Ordinary heavy cast iron		4	1		6	
Cast-iron railway chairs		4	6		6	
Medium cast iron ..		3	17		9	
Light cast iron		3	13		0	
MIDDLESBROUGH—						
Short heavy steel	3	14		3 to 3	16	9
Heavy machinery cast iron		4	11		3	
Ordinary heavy cast iron		4	8		9	
Cast-iron railway chairs		4	8		9	
Medium cast iron ..		3	19		0	
Light cast iron		3	14		0	
BIRMINGHAM DISTRICT—						
Short heavy steel	3	9		3 to 3	11	9
Hematite ingot mould		5	10		9	
Heavy machinery cast iron		4	11		9	
Ordinary heavy cast iron		4	7		0	
Cast-iron railway chairs		4	7		0	
Medium cast iron ..		3	19		9	
Light cast iron		3	14		9	
SCOTLAND—						
Short heavy steel	3	14	0	to 3	16	6
Heavy machinery cast iron		4	13		9	
Ordinary heavy cast iron		4	8		9	
Cast-iron railway chairs		4	13		9	
Medium cast iron ..		3	16		9	
Light cast iron		3	11		9	

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 2s. 6d. extra

PIG-IRON*

N.E. COAST (d/d Tees-side area)—	
Foundry No. 1	123/-
,, No. 3	120/-
,, No. 4	119/-
Forge No. 4	119/-
Hematite No. 1	131/-
Hematite M/Nos.	130/6
N.W. COAST—	
Hem. M/Nos. d/d Glas. ..	131/-
,, d/d Birm.	142/6
MIDLANDS (d/d Birmingham dist.)—	
Staffs No. 4 forge	121/-
,, No. 3 fdry.	122/-
Northants forge	118/6
,, fdry. No. 3 ..	119/6
,, fdry. No. 1 ..	122/6
Derbyshire forge	121/-
,, fdry. No. 3 .	122/-
,, fdry. No. 1 ..	125/-
Phosphorus 0.5% to 0.75%	129/6
Phosphorus 0.1% to 0.5%	132/6
SCOTLAND—	
Foundry No. 1, Grangemouth	119/9
,, No. 3, Grangemouth	117/3
Cleveland No. 3, Glasgow	123/-
,, ,, Falkirk ..	120/-
Scottish hem. M/Nos. d/d..	131/-
SHEFFIELD (d/d district)—	
Derby forge	118/6
,, fdry. No. 3 ..	119/6
Lincs forge	118/6
,, fdry. No. 3 ..	119/6
W.C. hematite	136/6
LANCASHIRE (d/d eq. Man.)—	
Derby fdry. No. 3 ..	125/-
Staffs fdry. No. 3	125/-
Northants fdry. No. 3 ..	123/6
Cleveland fdry. No. 3 ..	125/-
Cylinder and Refined Irons	
North Zone..	168/-
South Zone..	170/6
Refined Malleable	
Birmingham and S. Staffs ..	165/6
Cold Blast	
South Staffs	217/-

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

BASIC:	£	s.	d.
Soft, u.t., 100-ton lots ..	10	10	0
Tested, up to 0.25% C. ..	10	15	0
Tested, 0.25 to 0.33% C.	10	17	6
Tested, 0.33 to 0.41% C...	11	0	0
Hard (0.42 to 0.60% C.)..	11	17	6
,, (0.61 to 0.85% C.)..	12	7	6
,, (0.86 to 0.99% C.)..	12	17	6
,, (1% C. and up) ..	13	7	6
Silico-manganese	14	5	0
Free-cutting	12	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	13	15	0
Case-hardening	14	12	6
Silico-manganese	14	10	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C. ..	12	2	6
Basic hard, 0.41 to 0.60% C.	12	10	0
Acid, up to 0.25% C. ..	14	5	0

Other Semi-products, etc.

Tin bars	10	7	6
Sheet bars	10	7	6
*Wire rods, soft basic ..	15	4	0
,, hard basic ..	18	12	6
,, free-cutting ..	17	12	6
,, acid	22	3	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast) ..	14	3	0
Boiler plts. (N.E. Coast) ..	15	0	6
Chequer plts. (N.E. Coast)	15	13	0
Angles, over 4 un. ins. ..	13	13	0
Tees, over 4 un. ins. ..	14	13	0
Joists, 3 in. × 3 in. and up	13	13	0
Rounds and squares, 3 in. to 5½ in.	14	13	0
Rounds under 3 in. to ⅜ in. (untested)	15	8	6
Flats—over 5 in. wide ..	13	18	0
,, 5 in. wide and under ..	15	8	6
Rails, heavy, f.o.t. ..	12	15	6
Hoops	16	3	6
Black sheets, 24 g. (4 t. lots)	19	7	6
Galv. cor. shts. (,,)	22	12	6
Galv. flat shts. (,,)	23	2	6
Galv. fencing wire, 8g. plain	24	7	6

FINISHED IRON

	£	s.	d.
CROWN IRON:			
England and Wales ..	15	2	6
Scotland	15	2	6
Ireland, f.o.q.	15	15	0
No. 3 BARS:			
England and Wales ..	12	5	0
Scotland	13	7	6
Ireland, f.o.q.	12	17	6
No. 4 BARS:			
England and Wales ..	12	15	0
Scotland	13	12	6
Ireland, f.o.q.	13	7	6
STRIP:			
England and Wales ..	16	10	0
STAFFS MARKED BARS, f.o.t...	18	0	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated August 13, 1940.

	Dols.
No. 2 foundry, Phila.	24.84
No. 2 foundry, Valley	23.00
No. 2 foundry, Birm.	19.38
Basic, Valley	22.50
Malleable, Valley..	23.00
Grey forge, Valley	22.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
Wire rods	2.00
	Cents.
Iron bars, Chicago	2.25
Steel bars	2.15
Tank, plates	2.10
Beams, etc.	2.10
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., No. 24	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

Welsh foundry	42/6 to 44/-
,, furnace	31/6 to 33/-
Durham foundry	39/6
,, furnace	33/5
Scottish foundry	42/6 to 47/6
,, furnace	31/6

TINPLATES

f.o.b. Bristol Channel ports

I.C. cokes	20 × 14 per box ..		28/-
,,	28 × 20 ,, ..		56/-
,,	20 × 10 ,,	39/6 to	40/6
,,	18¾ × 14 ,, ..		29/-
C.W.	20 × 14 ,, ..		27/-
,,	28 × 20 ,, ..		55/-
,,	20 × 10 ,, ..		39/-
,,	18¾ × 14 ,, ..		28/-

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.	Per lb.
Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g. ..	10½d.
Wire	10½d.
Rolled metal	9½d.
Yellow metal rods	8½d.

COPPER TUBES, etc.	
Solid drawn tubes	14½d.
Brazed tubes	14½d.
Wire	9½d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	13½d.
Wire	15½d.
Rods	15½d.
Tubes	20½d.
Castings	17d.

Delivery 3 cwt. free.
10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

AVERAGE MONTHLY PRICES OF STEEL BOILER PLATES IN ENGLAND

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1903	7 10 0	7 10 0	7 15 0	7 5 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	6 17 6	7 3 11½
1904	6 12 6	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 11½
1905	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 17 6	6 10 0	7 5 0	8 0 0	8 0 0	7 1 3
1906	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 10 0	8 0 10
1907	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 0 0	8 0 0	8 8 4
1908	7 10 0	7 10 0	7 10 0	7 5 0	7 5 0	7 5 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 3 9
1909	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 0 0	7 0 0	6 18 9
1910	7 0 0	7 0 0	7 1 3	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 5 0	7 10 0	7 10 0	7 10 0	7 5 1
1911	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 10 0	7 14 0	7 10 4
1912	7 18 9	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 15 0	8 16 3	9 0 0	9 2 0	9 5 0	8 11 2½
1913	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	8 19 0	8 15 0	8 5 0	7 15 0	7 15 0	8 17 0
1914	7 15 0	7 15 0	7 15 0	7 13 9	7 10 6	7 5 0	7 0 0	8 0 0	8 2 6	8 5 0	8 5 0	8 5 0	7 15 11½
1915	8 14 0	9 10 0	9 17 6	10 10 0	10 10 0	11 0 0	11 0 0	11 0 0	11 0 0	11 4 0	12 0 0	13 0 0	10 15 5½
1916	13 0 0	13 0 0	13 0 0	12 15 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 12 11
1917	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1918	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0	12 10 0
1919	13 0 0	15 0 0	15 0 0	15 0 0	16 5 0	19 17 6	21 0 0	21 10 0	21 10 0	21 10 0	21 15 0	23 10 0	18 9 9
1920	26 0 0	28 0 0	28 5 0	28 10 0	29 5 0	30 0 0	30 0 0	30 0 0	30 10 0	31 0 0	31 0 0	31 0 0	29 9 2
1921	30 5 0	29 0 0	25 0 0	25 0 0	25 0 0	23 0 0	21 0 0	20 10 0	19 0 0	17 10 0	16 0 0	14 16 0	22 1 9
1922	14 10 0	14 10 0	14 10 0	14 10 0	14 10 0	13 1 8	13 10 0	12 15 0	12 10 0	12 10 0	12 10 0	12 6 0	13 10 9
1923	12 8 9	13 6 0	14 0 0	14 0 0	14 0 0	14 0 0	13 12 6	13 0 0	13 0 0	13 0 0	13 0 0	13 10 0	13 9 1½
1924	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	13 10 0	14 0 0	14 0 0	13 11 0	13 5 0	13 5 0	13 10 11
1925	13 5 0	13 5 0	13 5 0	13 1 0	12 15 0	12 15 0	12 15 0	12 15 0	12 7 6	11 14 0	11 10 0	11 10 0	12 11 5½
1926	11 10 0	11 10 0	11 10 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 5 0	11 6 3
1927	11 5 0	11 5 0	11 5 0	11 2 6	11 0 0	11 0 0	11 0 0	11 0 0	10 16 0	10 10 0	10 10 0	10 10 0	10 19 0½
1928	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0
1929	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 10 0	10 5 0	10 1 3	10 1 3	10 1 3	10 1 7	10 6 8
1930	10 2 9	10 3 5½	10 3 9	10 3 9	10 3 6	10 2 6	10 2 6	10 2 6	10 2 2½	9 19 6	9 16 3	9 16 3	10 1 8½
1931	9 15 0	9 15 0	9 10 11	9 6 9	9 5 0	9 5 0	9 7 0	9 7 9½	9 8 9	9 5 9	9 5 6	9 9 6	9 9 4
1932	9 5 0	9 2 6	8 18 6	8 17 6	8 16 6½	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 16 3	8 17 10
1933	8 10 0	8 10 0	8 10 0	8 8 9	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 5 0	8 6 0	8 7 6	8 6 10½
1934	8 8 1½	8 10 7½	8 16 6	8 17 6	8 6 3	8 6 3	8 6 3	8 5 7½	8 5 0	8 5 0	9 5 0	9 5 0	8 11 0
1935	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0
1936	9 5 0	9 5 0	9 5 0	9 5 0	9 8 1½	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 17 6	9 18 1	9 12 7½
1937	10 0 6	10 0 6	10 0 6	10 0 6	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 5 6
1938	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0	11 18 0
1939	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	11 8 0	12 8 0	12 8 0	11 11 4
1940	12 8 0	13 8 0	13 8 0	13 8 0	13 8 0	13 8 0	15 0 6	15 0 6	—	—	—	—	—

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(A remittance should accompany instructions.)

SITUATIONS WANTED

FOREMAN or Assistant seeks re-engagement; experienced general engineering up to 10 tons. Repetition, also non-ferrous including manganese bronze. Age 34. Keen and energetic. Technically trained. First-class references.—Box 452, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

MANAGER or Assistant Foundry Manager desires re-engagement; Light Alloys to Air Ministry Specs.; Alloy Cast Iron; Grey Iron; green sand; dry sand. Jobbing and machine moulding; pattern shop. (391)

BUSINESS FOR SALE

FOR SALE.—Small Ironfoundry in North Midlands, specialising in Grey Iron Castings up to 10 cwts. Going concern. Owner retiring.—Box 440, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MACHINERY

WANTED, Cupola, one ton per hour.—Particulars and price to H. BREAKELL & Co., Pitt Street, Blackburn.

WANTED, 8/12-ton Jolt Machine, Jackman type, 20-in. to 30-in. bore.—Full particulars to Box 446, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

CRUCIBLE FURNACES (two), new, for Sale; 220 lbs. brass; one gas, one coke fired; very efficient design.—Box 454, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

PLANT FOR SALE.—Balance Blast Cupola, by Pneulec, new 1936; complete with spark arrester, 50-cwt. receiver and blower. Output 5 tons per hour. Height to spark arrester, 67 ft. 6 in. Built in sections; could easily be shortened.—Box 456, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

SAND PLANT.—CHEAP.

6-ft. Macnab Sand Preparing Mill.
4-ft. 6-in. August type Intensive Mill.
4-ft. New Underdriven Mill.
4-ft. Secondhand Underdriven Mill.
A. HAMMOND, 14, Australia Road, Slough.

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For the successful prosecution of the war the need for Plant and Machinery is as urgent as the need for men. Have you any surplus plant which might be set to work in the national interests? *We will either purchase outright, or negotiate the sale for you on a commission basis*

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MACHINERY—*Continued*

TILTING FURNACE wanted, coke or oil, 600-lbs. capacity, must be in good condition; state whether lip or centre axis and price.—Box 448, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

PNEULEC ROYER Sand Mixing Machine (No. 2) for sale; had little use and in first-class condition.—Box 444, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

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Standard ¾-in. Git Cutter.
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Several Tilting Furnaces, also Stationary Furnaces.

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FOR SALE.—One Incandescent Gas Furnace, with four burners, size of Oven, 1 ft. by 1 ft. by 2 ft. deep. Pyrometer by Elliott Bros. & Company, Limited; nearly new; £55.—ERICSSON BROS., LIMITED, 154, West Street, Erith, Kent.

SAND MIXERS AND AERATORS.—The "Breakir" Centrifugal Machine is *THE* machine. Outputs 10 cwts. to 8 tons per hr.—W. BREALEY & Co. LTD., Station Works, Ecclesfield, Sheffield.

CUPOLAS

2 ft. 6 in. dia., 15-cwt. per hr. Cupolette.

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Macdonald Jolter, table 72 in. by 54 in.
Tabor 16-in. Shockless, table 72 in. by 48 in.
Tabor Portable Shockless Rollover, table 40 in. by 30 in.
Tabor ditto, table 27 in. by 20 in.
Tabor 21 in. by 16 in. squeeze.
Zimmerman Type R.P.W.2 Jolt Squeeze turnover, table 36 in. by 20 in.
Mumford Type (Jackman) Swing Headpress, 13 in. by 15 in. and 14 in. by 16 in.
Mumford Pneumatic Core Jolters having 15-in. by 20-in. and 12-in. by 12-in. tables.
Britannia No. 1 "Coventry" Pneumatic Turnover Jarr Ram, table 30 in. by 28 in.
50 Air Compressors; 500 Electric Motors, Dynamos, etc.

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MISCELLANEOUS

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MISCELLANEOUS—*Continued*

Stocks of

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PLUMBAGO
TERRA FLAKE

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VAUGHAN, JONES & CO.,

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'Phone: 22377 SLOUGH

TWO NEW Core blowers for bombs.
30" Constructional Cupola.
36" Cupola by Geo. Green.
46" Cupola by J. W. Jackman.
5 ft. Cupola by Pneulec.
JOLT SQUEEZE "JACKMAN" MOULDING MACHINES, 14" x 16", as new. £90 each.
Morgan 250 lb. Tilting Furnace (Two).
Morgan 600 lb. Oilfired Tilter.
NEW PIT FURNACES 150 lbs. capacity, oil or coke fired. £35 each.
NEW SHOTBLAST CABINET PLANTS with motor driven Exhaust Fans, complete, all sizes. Prompt delivery.

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